Environmental Guidelines for Beef Producers

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Environmental Guidelines for Beef Producers

Preface

The Beef Cattle Industry and the Environment

Agricultural production in British Columbia is very diverse. However, a common need for all agriculture is to use and sustain the land and water resource for crop and animal production. The long term existence of the agricultural industry is dependent upon protecting this resource base, requiring farmers and ranchers to use environmentally sound agricultural practices. Farming practices need to be reviewed to ensure that everyday farm management is in harmony with the environment. Some farm practices that have been used for many years, when evaluated today, may need to be changed.

Major management concerns in the BC beef cattle industry include the access of cattle to natural water sources and the handling and use of manure. There is a need for cattle to have access to natural water sources, especially on rangeland and pasture situations. Although beef cattle manure is a valuable source of nutrients and organic matter for plant production, incorrectly managed these same valuable nutrients can harm the environment. Most beef cattle operators recognize the need to manage their operation in an environmentally responsible manner.

It is with a strong awareness of the sensitivity of the environment that these guidelines have been written. They are intended to ensure that not only a sustainable environment for agricultural production continues, but also a safe environment for others is achieved.

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Environmental Guidelines for Beef Producers

1: Introduction

The beef cattle industry uses the land and water resource in a wide range of production systems, from rangeland to highly concentrated beef cattle feedlots. This use of a wide range of production systems, and the sensitivity of the environment, makes operating in an environmentally sustainable manner a significant challenge.

Federal and Provincial laws exist to protect the environment from contaminants from many sources, including agriculture. For example, the Provincial Code of Agricultural Practice for Waste Management contains standards for environmentally sound agricultural practices.

The purpose of these guidelines is to describe management options that are environmentally sound, and comply with existing Federal and Provincial environmental laws. These guidelines describe *generally acceptable farming practices* and apply to all beef cattle operations in BC. However due to local differences, not all portions of the guidelines need apply to every producer. To prevent pollution from occurring, producers may need management options not found in these guidelines. The individual producer must find, and put into use, these other options to prevent pollution. A professional qualified in environmental assessment should review these options before use.

The BC Federation of Agriculture and its member organizations co-operated in the development of this publication. Information in this publication is based on the best available research data and years of experience.

1.1: Use of the Guidelines

People trained or with experience in beef cattle production should use these guidelines to evaluate current beef cattle management practices. Producers should adopt changes, if necessary, to protect the environment.

Individuals not knowledgable in ranch or feedlot practices should not extract portions of this publication, nor draw inference, without considering all aspects of the problem.

Governments are encouraged to use these guidelines when dealing with environmental issues affecting the beef cattle industry. However, governments should not adopt any part of these guidelines literally into legislation. Remember, not all portions of the guidelines need apply to every producer.

Beef cattle operators are subjected to nuisance complaints from neighbours. These complaints could be unjustified where producers are following *generally accepted farming practices.* These guidelines can be used when assessing nuisance issues. To protect producers from such complaints, the Province enacted the Agriculture Protection Act.

Some terms not defined in the text are explained in the Glossary of Terms (Appendix G).

To aid in future revisions your comments on this publication are requested. An evaluation form is attached on the last page for your suggestions or comments.

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Environmental Guidelines for Beef Producers

2: Legislation

This section deals with Local, Provincial and Federal government environmental legislative requirements affecting beef cattle operations. Each level of government has legislative requirements to prevent pollution or nuisance. Compliance with one agency doesn't necessarily mean that those requirements satisfy all agencies. Non-compliance with the legislative requirement of an agency can be serious. For example, BC Ministry of Environment, Lands and Parks could require a producer to get a permit to continue to operate.

There are several non-regulatory programs that support producers in meeting the various legislative requirements. These programs encourage the implementation of farm practices that protect the environment. Programs under the BC Ministry of Agriculture and Food are explained in Appendix A. Ministry programs include: Best Agricultural Waste Management Plan, Best Soil Management Plan, Agricultural Land Development Assistance and The Nitrogen Behaviour Simulation Computer Model. The BC Federation of Agricultures, Agricultural Environmental Protection Council is explained in Appendix B.

2.1: Local Government

Local governments can enact and enforce a variety of land use plans and zoning by-laws. A zoning by-law can identify particular areas for agriculture use, within a region or district. Zoning by-laws can also establish specific setbacks for the siting of farm buildings. Local governments use specific setback distances from lot lines to help reduce conflicts between neighbours. Setbacks from watercourses are intended to reduce pollution.

The Municipal Act gives local governments authority to establish legislation. However, Legislation within the Agricultural Land Reserve is subject to review by the Agricultural Land Commission.

Existing beef cattle operations not in compliance with a new by-law are non-conforming. This means local government may allow the operation to continue but be limited to the existing size. Expansion is permitted if the full operation meets the requirements of the new by-law.

The number of by-laws that affect agriculture varies with each local government. Local government legislation can regulate:

- specific areas within a Region or Municipality where beef cattle production is permitted;
- specific setback distances from lot lines for farm buildings;
- building requirements in flood plains;
- nuisance, e.g., excessive noise from farm machinery; and
- setback distances from farm facilities to watercourses.

2.2: Provincial Government

Five Provincial Government Ministries in British Columbia administer Acts that impact farm practice. When Provincial and Federal Acts or regulations change, producers must meet the changes. This is because there is no non-conforming status as in local government legislation.

MINISTRY OF MUNICIPAL AFFAIRS, RECREATION AND CULTURE

Municipal Act. This Act gives local governments the authority to write by-laws that control the use and development of land. Community plans, land use by-laws, and development permits are methods used to control land use. The Municipal Act also gives local government the authority to make by-laws that control nuisance.

MINISTRY OF HEALTH

Health Act. This Act regulates farm practices that may be a health hazard. A health hazard exists when nutrients or pathogens cause a health problem. Sanitary regulations address slaughtering facilities, dead animal disposal and in-barn washroom facilities.

MINISTRY OF ENVIRONMENT, LANDS AND PARKS

Waste Management Act. This provincial legislation is responsible for controlling pollution from the agricultural industry.

This Act defines pollution as "the presence in the environment of substances or contaminants that substantially alter or impair the

usefulness of the environment". The Province has enacted an *Agricultural Waste Control Regulation*, and a *Code of Agricultural Practice for Waste Management*. A copy of the complete Regulation and Code is in Appendix C.

Producers who conform to the Code are exempt from holding a Waste Management permit. This does not imply that a beef cattle producer is exempt from the rest of the Act. A producer must obtain a Waste Management Permit to use non-agricultural wastes. Agricultural wastes not handled as outlined in the Code also require a Waste Management Permit.

The Waste Management Act contains a regulation that apply to the management of *Special Wastes*. Waste oil and pesticide containers are considered special wastes.

Pesticide Control Act. This act applies to the sale, transportation, storage, preparation, application and disposal of pesticides. The Act requires Pesticide Use Permits for use on public land as well as on private land used for forestry, transportation or public utilities.

MINISTRY OF AGRICULTURE AND FOOD

Agriculture Protection Act. This act protects beef cattle producers from the threat of unwarranted nuisance suits. Protection against such suits depends upon reasonable operation in accordance to generally accepted farm practices. Protection also requires that the operation comply with other relevant local, provincial and federal legislation related to the farm practice being challenged in the nuisance suit. Only beef cattle operations within the Agricultural Land Reserve qualify for protection under the Act.

MINISTRY OF TRANSPORTATION AND HIGHWAYS

Highways Act. Any noxious, or filthy substance, or dead animals left on a road right of way, is unlawful under this Act.

Dirt or manure left on the road can be a source of pollution or nuisance complaint. The Act requires dead animals be removed from the road right of way. Upon receiving a complaint the RCMP or local police will enforce this Act.

2.3: Federal Government

Fisheries Act. The Fisheries Act is the main Federal Act that addresses pollution from farms.

This Act prohibits an unauthorised deposit of a harmful substance into

water frequented by fish as well as water that may eventually enter water frequented by fish. Shellfish are protected the same as fish. The Act also prohibits the harmful alteration, disruption or destruction of fish habitats. Therefore, any work in or about a fish watercourse requires pre-approval. Environment Canada has the lead role in the enforcement of the pollution control parts of this Act. Examples of potentially deleterious substances are: manure and runoff from overwintering and feedlot areas, woodwaste leachate, pesticides, and improperly disposed of mortalities.

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Environmental Guidelines for Beef Producers

3: Pollutants

Some items that are produced or used on a beef cattle operation can cause pollution. These items when released to the environment in sufficient concentration are pollutants. This section explains the impact the pollutants have on: air, soil, and water.

3.1: Impacts on Air

Items that cause air pollution and where they come from are discussed below.

Burning. Burning introduces smoke and particulate into the air. Burning also releases global warming gases to the atmosphere.

Global Warming Gases. Certain gases in our environment act like a greenhouse, trapping the sun's heat, which then heats our atmosphere and causes global warming. This process is known as the greenhouse effect. The primary gases of concern are carbon dioxide, methane and nitrogen oxides.

Nitrogen Oxides. Nitrogen Oxide emissions cause ground-level ozone formation during the summer. Elevated values of ground-level ozone have been associated with crop damage.

Odours. The importance of odours in human terms is related primarily to the mental stress they produce, rather than any physical harm. Offensive odours can cause poor appetite for food, lowered water consumption, impaired breathing, nausea and vomiting. Odours can be generated from livestock areas, manure spreading and from rotting feed.

Pesticides. Air can be polluted with pesticides by: spray droplets, mists, dusts or vapours. Once in the air they can be transported to water bodies, non-target organisms, or soil. They can also be concentrated within enclosed spaces and harm unprotected applicators, and non-target organisms.

3.2: Impacts on Soil

Items that can cause soil pollution and where they come from are discussed below.

Carbon:Nitrogen (C:N) Ratio. Soils have an equi-librium C:N ratio of the order 12:1 to 15:1. The application of wastes with a higher C:N ratio (woodwaste has a C:N ratio of 300:1) will tie up free nitrogen with the waste. The continued application of such a waste will cause continued nitrogen tie up until a new soil equilibrium is attained. Soil with a high C:N ratio will have less nitrogen available for crop use.

Metals. Most metals are relatively immobile and crop uptake is small. Application of wastes containing metals will result in an unwanted accumulation in the topsoil. Crop yield reduction or even toxicity can occur for some crops at relatively low levels of metals. If waste containing metals are applied to soil, precautionary measures must be taken. Once build-up has occurred and damage produced, it is too late to correct. Although levels in the soil may not harm plant growth, plant levels may be toxic to animals. Ingestion of soil by livestock may also lead to metal toxicity in animals. Some types of manure contain high levels of metals (mainly copper, and zinc). Waste oil and hydraulic fluids also contain high metal levels.

Nutrients. The primary nutrients are nitrogen, phosphorus, and potassium. The secondary nutrients are sulphur, magnesium and calcium. The micro nutrients are iron, manganese, boron, chlorine, zinc, copper, and molybdenum. If applied in excess amounts to soil these nutrients can reduce crop yields or become toxic to plants. Furthermore, when levels in the soil are not harmful to plant growth, nutrient levels in plants may be harmful to animals. The main source of nutrients is manure or fertilizer. Other sources include dead animals and feed.

Pesticides. Soil can be polluted with pesticides by: spills during mixing and loading, application equipment overflow, improper disposal, or exceeding the proper rate of application. When pesticide pollution of soil occurs, beneficial insects may be killed, crops may not be able to be grown, or the type of crops may be limited. Animals or birds may also be harmed or killed by eating contaminated crops, or soil. Animals or birds may suffer adverse effects such as weight loss, or reproductive failure. They could also accumulate pesticides in their tissues, making them unfit for consumption.

Petroleum. Petroleum (gas, diesel, kerosene) and petroleum based products (oils, greases and solvents) are complex organic compounds that contain metals and other contaminants. Many petroleum products

are volatile, that results in them being lost to the air. However, many more of these products either firmly or loosely bind to soil particles. In either case they will restrict the growth of plants. Petroleum products that are loosely bound to soil can be either washed or leached into surface or ground water.

Plant Diseases. Transfer of plant diseases is common in areas where farm equipment moves either from field to field or farm to farm. In many cases, bacteria, fungi or other organisms growing on the crop or in the soil are picked up by equipment. Plant disease organisms may also be transported from field to field by livestock. Contamination can result from plant diseases being moved in manure. Plant disease infestations can result in significant losses in crop quality and/or yield. Severe contamination may reduce the range of crops that can be grown.

Salts. The salt content of a manure depends on the feed constituents. Many manures contain between 10 and 13% salts (dry weight basis). High application of manure, annually applied, can increase soil salinity in areas of low precipitation. Many crops are adversely affected by elevated salinity levels.

Woodwaste Breakdown By-product. Woodwaste (sawdust, shavings, chips, hogfuel, bark, etc.) may be a useful soil conditioner, but can also have negitive impacts on soil. When exposed to water, air and soil microbial activity, woodwaste breaks down and releases soluble compounds that can leadto contamination of soil. Some of these compounds, particularly tannins, tropolones and resin acids are toxic to some plant life. Woodwaste breakdown by-products are also acidic and will cause metals and nutrients to be released from the soil. Because the breakdown by-products are leachable they can enter groundwater. High application rates of woodwaste to the soil surface or incorporated into the soil will cause nutrient imbalances or shifts in soil microbial populations. For example, a heavy application of sawdust that is incorporated into the soil will cause nitrogen deficiencies (see Carbon: Nitrogen Ratio) and may cause the soil pH to drop.

3.3: Impacts on Water

Items that cause water pollution, and where they come from are discussed below.

Ammonia (NH3). This chemical, which comes from urine or fertilizer, is highly toxic to fish. Runoff from over-fertilized crop land or from uncovered manure piles can have a high ammonia concentration.

Metals. Metals include: nickel, manganese, lead, chromium, zinc, copper, iron and mercury. Trace quantities of some of these metals are necessary for growth of biological life. The presence of any of these metals, in even slightly elevated quantities, can interfere with many beneficial uses of the water. Elevated levels of metals are toxic to most living things. Metals may come from manure, waste oil, hydraulic fluids or can be released from soils into groundwater by acidic leachate from woodwaste products.

Nitrate. Once applied to the land, the nitrogen in manure or fertilizer can convert to the nitrate (NO3) form, which is water-soluble. Because it is soluble, it does not attach to soil particles as ammonium nitrogen does, and so it is easily leached from the soil. Once past the root zone, nitrates can continue moving downwards to the groundwater and into drinking water supplies. Nitrates which are converted to nitrites in a baby's stomach, can cause a disease in infants known as blue-baby syndrome. These nitrites reduce the oxygen-carrying capacity of the blood. In extreme cases, this disease can be fatal. After the baby is about six months old, its stomach becomes more like that of adults, and this disease poses less of a threat. Medical advice states that a nitrate nitrogen level over 10 mg/l in drinking water is a health risk. The tolerance level of livestock to nitrate nitrogen in water is higher than the health standard for humans. As much as 40 mg/l may be safe for cattle, providing feed nitrate levels are low.

Nutrients. Nutrients (primarily Nitrogen and Phosphorus) accelerate eutrophication (rapid aging) of water bodies. Nitrogen can stimulate eutrophication in lakes, but phosphorus is generally the critical limiting nutrient. In streams both nitrogen and/or phosphorus can be the limiting nutrient. The most visible effects of eutrophication are massive blooms of phytoplankton (algae). In some cases the blue-green algae is toxic to cattle. The nutrients can come from manure or fertilizer going directly into a watercourse, livestock area runoff or nutrient rich soil eroding off fields.

Oxygen Demand. Oxygen demand is measured by either BOD (biochemical oxygen demand) or COD (chemical oxygen demand). When waste enters a water body, its decomposition requires oxygen. This removes oxygen that would otherwise be available for fish and other aquatic life. Therefore, wastes with high levels of BOD when they enter a watercourse may kill fish. The BOD of beef cattle manure is about 30 times stronger than human waste. Wasted feed and silage juices can have BOD's three to five times higher than manure.

Pathogens. All animal wastes contain micro-organisms that these may include bacteria, viruses, and parasites. Some organisms in waste

may be pathogenic (disease-causing) either to animals of the same species or of different species. In addition, more than 100 diseases are transmissible between animals and human beings. Although the water itself may not be affected by the organisms, the water becomes a path for transmitting diseases to animals and humans. Pathogens in cattle manure or from dead animals cause two water quality problems. When they enter estuaries by way of runoff, they contaminate shellfish beds. This renders the shellfish unfit for human consumption. Pathogens from livestock waste can contaminate surface or ground water drinking supplies.

Pesticides. Both surface and ground water can be polluted with pesticides. Pollution occurs by runoff or leaching of soil that has absorbed pesticides, direct application to water, drift, or accidents such as spills. Once water is polluted, any organism living in the water or using the water may be affected. These include people, animals, fish, plants, birds and wildlife.

Petroleum. Petroleum and other oil substances can be harmful in water supplies. Oil in suspension can act on the gills of fish to interfere with respiration. Petroleum destroys algae and other plankton, thereby removing a source of fish food, and oxygen. Oily substances that settle can coat the bottom of a water body, destroy organisms, and interfere with spawning areas. Soluble and suspended materials ingested by fish can taint the flavour of the flesh or have a direct toxic action on fish or fish food. If films of free oil are present they can interfere with the natural processes of stream aeration and photosynthesis. Petroleum products are less toxic to humans and animals, however, some forms of petroleum have been linked to cancer.

Solids. Solids in water can come in two forms, suspended or dissolved. Suspended solids are such things as clay, silt, oils, pathogens, etc., where as dissolved solids include nutrients, metals, etc. Either form of solids can be harmful to fish especially ammonia which will readily kill fish. Other dissolved solids can cause the BOD of the water to rise. Suspended solids such as silt can damage the gills of fish or smother the eggs of aquatic life.

Woodwaste Breakdown By-products. Woodwaste (sawdust, shavings, chips, hogfuel, bark, etc.) may be a useful soil conditioner, but can also have negitive impacts on soil. When exposed to water, air and soil bugs, woodwaste breaks down and releases soluble compounds that can lead to contamination of water. Some of these compounds, particularly tannins, tropolones and resin acids are toxic to some aquatic life. Woodwaste breakdown by-products have high BOD and COD levels are acidic and will cause metals and nutrients to

leach out of soil. Because the breakdown by-products are leachable they can enter either surface or ground water. Woodwaste breakdown by-products cause accelerated fungal growth in receiving waters.

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4: Land Area Management

This section deals with the environmental concerns regarding the land areas used for beef cattle. This includes: grazing, seasonal feeding and confined livestock areas. It is important for beef cattle producers to understand how the Code (Appendix C) defines these three areas:

- **Grazing Area.** This is a pasture or rangeland area where livestock are primarily sustained by direct consumption of feed growing on the area.
- **Seasonal Feeding Area.** This is an area used for both crop production and seasonally for feeding livestock. The livestock are primarily sustained by supplemental feed. Beef cattle producers commonly know these areas as overwintering sites.
- **Confined Livestock Area.** This is an outdoor, non-grazing, non-crop area where livestock are confined by fences, other structures or topography. Beef cattle producers would most commonly know these areas as feedlots, paddocks, corrals, exercise yards and holding areas.

4.1: Grazing Areas

Where possible, beef cattle producers allow livestock to consume forage by direct grazing. Two primary grazing situations are common: grazing on rangeland and grazing on pasture. The differences (besides crown versus deeded ownership) are often the quantity and quality of forage produced. Beef cattle can be grazed any month of the year in BC, however most grazing occurs from spring to fall during the period of greatest forage production.

Cattle are dispersed when grazing so that manure is also dispersed. Therefore, additional spreading of manure is not required. In these areas, cattle may have access to natural water sources for drinking

providing the cattle do not cause pollution. Whenever possible the use of livestock waterers is encouraged (see Section 5, Water).

RANGELAND

Rangelands are lands where native vegetation includes grasses, forbs or shrubs suitable for grazing. While they may have been revegetated to include tame forages, intensive forage production, irrigation or fertilization is not normal. Cattle densities on rangeland are very low, often allowing for numerous hectares per animal. These lands may be Crown or privately owned and are commonly grazed spring to fall with very limited winter use.

Traditional grazing involves the keeping of cattle on rangeland to make maximum use of the grazing resource, consistent with good range management practices. In general, access of grazing animals to surface water sources is acceptable, providing the cattle and their manure do not cause pollution. Environmental concerns related to beef cattle use of natural water sources on rangeland are; a) stream bank erosion, and b) pollution caused by manure. To reduce these concerns consider the following points in watering beef cattle on rangeland:

- Discourage cattle from loitering at watering sites.
- Locate salt blocks and mineral licks away from watering sites.

- Where possible, restrict or limit access to bogs and other low muddy areas where livestock may loiter if the bog drains to a watercourse.
- Where practical or if pollution is occurring at an undeveloped natural water source:

  -- Develop sites on natural water sources to limit any cattle impacts on water quality, or
  -- Use livestock waterers located so as to reduce watercourse impacts.

PASTURE

Pasture lands, where forage includes native and tame species, are often managed for improved production with the use of irrigation and fertilization. When supplemental feeding is not done, cattle grazing densities are low, although often higher than on rangeland. Like rangeland, manure is dispersed and available as a crop fertilizer without any additional spreading required. As for rangeland, pastures are normally grazed spring to fall however some winter grazing is possible. Pasture land can be considered in two categories depending on the moisture available to the plants.

Pastures That Are Moisture Limited. Due to low precipitation or the lack of irrigation, these pastures will have low productivity. Because these pastures have low grazing potential and stocking rates, manure production is therefore limited and will be similar to conditions on rangeland. Cattle should use livestock waterers where possible. However, access to natural water sources is permitted. Consider the points discussed for rangeland.

Pastures That Are Not Moisture Limited. Where rainfall is adequate or when irrigation is used, these pastures have the potential for higher productivity. Therefore, increased stocking rates may be used over longer periods. Animals do not excrete more nutrients then they consume in feed. With no supplemented feeding, manure nutrient produced will not be greater than the nutrients used by the crop. When fertilizer is applied (added in addition to manure from the grazing cattle) care must be used not to exceed crop needs. For acceptable manure and fertilizer application rates refer to Section 9.5, Manure Application Rates.

When grazing cattle on high production pasture, consider the following points:

- Cattle should use livestock waterers where feasible. However, access to natural water sources is permitted. Consider the points discussed for rangeland.
- Ensure no contaminated runoff from the pasture is allowed to enter any water course. See Seasonal Feeding Area Management under section 4.2, for points relating to runoff from feeding areas.
- Consider harrowing of pastures to break up manure piles.
- When irrigating pastures, apply water at a rate suitable for the soil and local climate to ensure no nutrient leaching. See the BCMAF, **BC Sprinkler Irrigation Manual** listed in Appendix F, Reference Material.

4.2: Seasonal Feeding Areas

While cattle graze for part of the year in BC, they must be fed for some period during winter. Producers often feed the cow herds in open fields that produce forage crops during the rest of the year. These overwintering sites are classified as seasonal feeding areas. Because feed is brought to these areas, cattle densities can be high and the resultant manure may be an environmental concern. On all sites, the manure produced must be used by the crops grown on the area. This use of manure by crops after feeding on a seasonal feeding area is the main difference between a seasonal area and a confined livestock area.

There are two environmental concerns relating to seasonal feeding areas. Firstly, the fertilizer value of the manure spread in a seasonal feeding area must not exceed the crop requirement. If it does, the area should be considered a confined livestock area. Secondly, the runoff from

seasonal feeding areas must not pollute surface or ground water.

All seasonal feeding areas must be evaluated individually and managed to reduce the risk of pollution occurring.

SEASONAL FEEDING AREA MANAGEMENT

Feeding site management influences whether or not a seasonal feeding area has a pollution concern. Feeding site management depends on a number of factors. Some of the factors are determined by the site (slope, precipitation, etc.), others can be controlled (cattle density and use, runoff control, etc.). A basic principle for environmentally correct seasonal feeding area management is that the crop grown removes the nutrients supplied by the manure.

A good seasonal feeding area must have the following factors:

- be operated in a way that does not cause pollution;
- have feeding locations at least 30 m (100 ft) from a watercourse, wells or domestic water intakes;
- have feeding sites distributed throughout the area to ensure manure is spread as a fertilizer;
- have approvals from BC Ministry of Environment, Lands and Parks for permanent feed bunks (a requirement of the Code); and
- have berms where necessary to prevent contaminated runoff from entering a surface watercourse and causing pollution.

In addition, a good seasonal feeding area should have the following factors:

- have ditches to divert clean off-site runoff away from the area; and
- have livestock waterers where possible or developed sites on natural water sources.

Good, low pollution risk, seasonal feeding areas will address the components of water, feed, manure, runoff, infiltration and site use. No two feeding areas will be alike but all will have similar concerns.

Manure Management on Seasonal Feeding Areas. Good manure management recognizes the fertilizer and soil conditioner values of manure. To avoid mechanical spreading manure, cattle can be encouraged to deposit manure over a complete crop area. This can be done by moving the feeding location throughout the feeding period. In doing so, manure concentrations can be avoided. Harrowing or complete tillage, following the feeding period, may be required.

The feeding location may be moved if feed is fed on the ground or with movable feed bunks or feeders. However, if permanent feed bunks are used on a seasonal feeding area, manure concentrations are likely, and natural spreading of manure is less likely to occur. Because of this, permanent feed bunks in a seasonal feeding area require approval from BC Ministry of Environment, Lands and Parks before use. The manure will have to be collected and redistributed over the feeding area.

Bedding in Riparian Zones. Beef cattle will seek shelter from harsh weather in treed or brush covered areas. If these sheltered areas are on upslope land away from watercourses then runoff can be managed. However, if this sheltered area is located along a watercourse, attention needs to be given to possible water contamination and fish habitat concerns.

Creek side, or riparian zones, can be sensitive to cattle use. In addition, manure deposited here may become a contaminant to the adjacent watercourse. Seasonal feeding areas that include riparian zones should be managed to encourage cattle to seek shelter and bedding away from the riparian zone.

The following are some management practices that can assist in maintaining healthy riparian

zones:

- Locate feeding (and livestock waterer if used) well back from water courses.
- Restrict water course access to developed watering sites only.
- Develop shelters away from the riparian zone (with windbreak fences or other structures).

SEASONAL FEEDING AREA EVALUATION

To help assist in determining whether a site (new or presently being used) may have pollution concerns, the following tables can be used. Because of the variability of seasonal feeding areas in BC, these tables should be used as a guideline only. The ultimate risk of pollution occurring can be very site specific. Therefore, each site must be evaluated accounting for all relevant site factors. Not all factors may be included in the tables.

The following tables are organized in three steps:

1. Table 4.1 -- factors that influence site runoff
2. Table 4.2 -- factors that influence runoff entering surface water
3. Table 4.3 -- factors that influence runoff entering groundwater

Runoff from a feeding site that enters surface or groundwater may or may not be considered pollution. This depends on the composition of that runoff and the nature of the receiving waters. However, beef cattle producers should attempt to reduce or eliminate runoff as the Code requires that runoff not go beyond the farm boundary.

A simple statement to remember to avoid pollution is: **"Keep manure out of clean water and clean water out of manure."**

Having assessed the feeding area with these Pollution Risk Evaluations, the next step is to determine what action to take. The following general recommendation can be followed depending on the pollution risk determined:

- **Low Pollution Risk.** These are areas that have no runoff or have runoff that is controlled. With continued good management these areas should not require extensive alterations. However, improvements in any of the factors could be considered. Figure 4.1 shows a low risk seasonal feeding area.
- **Medium Pollution Risk.** These are areas that have runoff and show some risk to either or both surface and groundwater. Improvements in one or more of the rating factors should be considered. These improvements may not require extensive alterations.
- **High Pollution Risk.** These are areas that have runoff and show significant risk to either or both surface and groundwater. They require improvements in one or more of the rating factors. Because factors such as slope, precipitation and flood hazard cannot be controlled, some high risk rated areas will require significant changes or abandonment in favour of a lower risk area.

To aid in this evaluation process, an Engineering Factsheet is available that assigns a numerical value to each of the rating factors in Tables 4.1, 4.2 and 4.3. See **Environmental Evaluation of Beef Cattle Seasonal Feeding Areas (312.100-1)** listed in Appendix F, Reference Material.

4.3: Confined Livestock Areas

When cattle are fed for growth and weight gain, they are often held in areas more confined than either grazing or seasonal feeding areas. Confined livestock areas are designed to get good animal performance from the feed provided. They include non-grazing sites where livestock are confined by fences, other structures or topography. These areas are not used as

cropland during part of the year as are seasonal feeding areas. Beef cattle producers would commonly use the terms feedlots, paddocks, corrals, exercise yards and holding areas for these areas. Because of the animal densities, the manure produced is in excess of the site requirements and manure must be scraped and mechanically spread on other land for use by crops.

In addition to manure concerns, runoff control measures and housing structures are more extensive than for other land areas used by beef cattle. The management level required depends on the amount of precipitation the site receives.

LOW PRECIPITATION LOCATIONS

In the interior of BC, beef cattle are fed for growing and finishing in open, unpaved feedlots because of the low annual precipitation (regions with less than 600 mm or 24 in annually). However, even in these dryland areas, runoff is a major concern and a prime consideration in the siting and layout of confined feeding areas. For instance, in Kamloops during the feeding season from November to April, the worst precipitation in 25 years totals 122 mm (4.8 in) or 1220 m3 for every ha (1 acre-foot of water for every 2.5 acre) of feedlot surface. While some is lost to evaporation, runoff must be considered.

Site Selection. Proper siting of dryland confined livestock areas will help to ensure an environmentally sound operation (see Figure 4.2). While no one site may have all the following factors, good sites should have many of the following:

- have as large a setback as practical from any watercourse;
- have a minimum set back from any watercourse of 30 m (100 ft);
- have met government siting bylaws;
- have access to a sufficient land base for manure to be used as a fertilizer;
- consider the natural site features (for more detail see section 7.1, Planning Beef Cattle Structures);
- have a south-facing slope as these sites are always warmer and dry out quicker;
- have a 2 to 4% slope as this will allow a feed bunk and alley along dry ground with drainage away to the lower side of pens;
- have the feed alley running north and south as this ensures no part of the feeding area or alley is continuously shaded from the winter sun;
- have terrain allowing runoff control as both off-site and on-site runoff must be controllable (existing land shape is important if extensive shaping is to be avoided);
- have all weather access for transportation; and
- have adequate livestock waterers as access to natural watercourses is not allowed.

Feed and Water Supply. Depending on size, a confined livestock area may have an extensive feed centre where grain, hay, chopped hay, silage and other feeds are stored, mixed and handled. Environmental concerns relating to these operations are detailed in Section 6, Feed, and include:

- adequate feeding site drainage and runoff control;
- all weather road access; and
- laid out so as to allow cleanup of spillage.

Water must be supplied to pens. Beef cattle in confined livestock areas can not have access to natural watercourse. The main concerns relating to water supply are outlined in Section 5.1, Livestock Waterers and include:

- proper installation to ensure cleanliness of the water;
- control of spillage or drainage from the waterer to ensure no runoff concerns; and

- hard surfacing around the waterer.

Manure. Confined livestock feeding results in manure accumulation and these areas must be cleaned. To ease cleaning, hard surfacing (usually concrete) is put along the feed bunk to the width of the cleaning tractor. Scraped manure may be mounded in the pen for cattle use as a bedded mound or removed to storage. See Section 8, Manure Storage. All manure must be used as a fertilizer.

Runoff. Runoff control cannot be over emphasized in confined livestock area layout and management. Both off-site and on-site runoff must be controlled if the area is to be environmentally successful. Runoff controls include the following:

- Diversion ditches or dikes should direct clean off-site water flow away from the area to reduce the volume of water that must be held on-site. This will also keep the pens drier.
- Proper grading of the pens to allow on-site contaminated runoff to be collected in an impervious containment basin.
- Pens should slope to a rear drainage ditch. As well this ditch should be graded to flow to one corner of the pens producing a diagonal slope across the pens (see Figure 4.2).
- Pen drainage ditches should slope to a containment basin.
- A two stage containment basin with a shallow sediment basin followed by a deeper liquid holding basin is often used. Runoff stops first in the sediment basin, allowing solids to settle out, then the liquid flows into the holding basin. Both basins can be cleaned annually and material spread on crop land.

See runoff control and collection details later in this section.

HIGH PRECIPITATION LOCATIONS

In coastal areas of BC, and those areas having greater than 600 mm (24 in) of annual precipitation, uncovered confined livestock areas may result in polluted runoff. If cattle are fed in open outside lots, the suggestions for Low Precipitation Locations apply. However even more attention will need to be given to runoff collection and storage. To over

come these pollution and runoff problems, cattle fed in high precipitation locations are often in covered feeding barns. These are essentially totally roofed feedlots with a higher stocking density than dryland feedlots. Roofed feedlots may require as few as 2.8 square metres (30 square feet) per head compared to dryland feedlots of 14 to 28 square metres (150 to 300 square feet) per head. Three basic barn designs are Deep Pack, Wedge Pack and Slatted Floor which differ in how bedding and manure are handled.

Deep Pack Barn. This design has a drive through layout with pens and feedbunks on both sides of a centre alley. Two variations are used:

- Combined Resting and Feeding Areas -bedding is added to the manure pack at regular intervals. The result being a solid manure and bedding pack requiring removal two to three times a year. Covered manure and bedding storage is required separate from the barn.
- Separate Resting and Feeding Areas - bedding is added to the manure pack in the resting area at regular intervals. The result being a solid manure and bedding pack requiring removal two to three times a year (see figure 4.3). The feeding area is separated from the resting area by a wooden fence. The feeding area uses no bedding with the result being a semi-solid manure that is scraped clean two or three times a week. Covered manure (both solid and semi-solid) and bedding storage are required separate from the barn.

Wedge Pack Barn. This barn is similar to the Deep Pack Barn except the structure is designed to allow for the use of a deep wedge-shaped bedding pack (see figure 4.4). Before

stocking, a pack of bedding is built up in a wedge shape against a reinforced rearwall in each pen. Action of animals walking on the slope works manure down onto the concrete apron along the feed bunk. Manure is regularly scraped from the apron and stored. This manure contains less bedding material than in Deep Pack Barns and may be an advantage where manure is sold for off farm use. While manure storage is required, no separate bedding storage is required.

Slatted Floor Barn. Although slatted floor barns have been used for years by pork and dairy producers, they are relatively new to the beef producer. They are expensive when compared to other confinement buildings. The major advantage of slatted floors for beef housing is that no bedding is required and manure handling labour is kept to a minimum.

Slatted floor barns can be designed for long term manure storage. However, to reduce the toxic gas problems and the high cost of construction of a deep pit, a shallow pit with mechanical scrapers may be used. The manure is removed from the shallow space below the slats to an outside storage facility.

RUNOFF CONTROL AND COLLECTION

Due to cattle densities, confined livestock areas require control and collection of runoff. The following discussion of runoff control is also relevant to grazing and seasonal feeding areas.

Perimeter Ditches. The on-site runoff must be stored. Every effort to reduce the volume of off-site runoff coming onto the site will reduce storage size and costs. Therefore:

- All off-site runoff should be directed away from the feedlot wherever possible (perimeter diversion ditches are the most common way of achieving this).

Grading for Runoff Control. If the pens are graded the on-site runoff will be easier to control and cattle performance will benefit. This requires a 2 to 4% slope down and away from the feed bunks. A similar slope is required from side to side along the back of the pens. This produces a diagonal slope across the pens towards the collection basin. Bedded mounds should run parallel to this diagonal slope to prevent runoff from ponding in the pens (see Figure 4.5).

Runoff Collection. Runoff from each feedlot pen should be directed to a collection basin for complete control. This will ensure that no contamination of surface or groundwater supply occurs. A two-stage runoff holding system works best as shown in Figure 4.6. This has a shallow paved settling basin followed by a deeper earth banked holding basin. Runoff stops first in the settling basin, then the liquid part trickles through a trash screen or narrow vertical slot into the holding basin. After drying, the solids remaining in the settling basin are scraped up, the holding basin is pumped out, and all the material is spread onto cropland as fertilizer. An earthen catch basin should be constructed only if it can be made leakproof. Subsoil investigations should be made when planning an earthen catch basin, to determine if it can be made leakproof (see section 8, Manure Storage).

Collection Basin Sizing. The storage volume of the runoff basin (for rainfall and snow melt during the feeding period) can be estimated using the following calculations (for calculation formula and details see Appendix D, Confined Livestock Runoff Calculation):

1. Choose the location listed in Table 4.4 that is closest to your feeding area.
2. For each location a precipitation coefficient is given.
3. This precipitation coefficient is the volume (cubic metres) of the collection basin needed for each 1000 m2 of area contributing to runoff. This runoff collection area includes the feeding area and upslope, off-site land that generates runoff that has not been diverted away from the feeding area.

A settling basin is not always installed, but is recommended. The settling basin surface should be about 2-1/2% of the area that contributes to runoff and be between 0.6 to 1.2 m (2

to 4 ft) deep. The settling basin volume is part of the total required basin volume (See example 4.1).

TABLE 4.1
RUNOFF RISK EVALUATION FOR A SEASONAL FEEDING AREA

These are mostly site factors which cannot be changed by management.

Slope of Feeding Area: The slope of a feeding site will determine to a large degree if runoff may occur. South facing slopes will often have a quick, difficult to control runoff from snow melt compared to north facing slopes. In addition, tall trees on the perimeter of a site may shade and modify snow melt and runoff.

- Flat ground (less than 2% slope) has the least chance of runoff.
- Slight (2 to 10%) or moderate slopes (10 to 15%) have greater chance of runoff.
- Steep slopes (over 15%) have the greatest chance of runoff.

Precipitation: The amount of precipitation will have a major affect on runoff. Influences like snow moisture loss to the air and snow removal reduce runoff, as may the distribution of precipitation (does it occur all in one month or evenly over the period?).

- Rain (and snow water equivalent) that occurs during the feeding period (plus two months following) is the main contributor to runoff.
- Less than 125 mm (5 in) is considered low and will have a small affect on runoff.
- From 125 mm to 200 mm (5 to 8 in) is considered moderate but will contribute to runoff.
- Over 200 mm (8 in) is considered sufficient to cause runoff in many cases.

Soil Drainage: Snowmelt on frozen ground is a major reason for runoff, especially in the BC Interior where late winter or early spring "chinooks" can cause quick melting. Because water cannot infiltrate the frozen ground it runs off the feeding area.

- Well drained (coarse textured) soils have a low risk of runoff. But see "Infiltration" in Table 4.3.
- Poorly drained (fine textured) soils have a high risk of runoff.
- Frozen (Impervious) soils also have a high risk of runoff.

Surface Water Entering the Area: This factor is most commonly controlled by perimeter ditches or berms to divert any clean runoff away from the feeding site. Many beef cattle producers do this as it often improves the site for cattle feeding by reducing mud problems.

- There are no concerns from off-site water if it has been totally diverted.
- If the water is only partly diverted from the feeding site, consider some additional control measures.
- If none of the upslope water is diverted, it all may become contaminated in the feeding site increasing the risk of runoff and will require control.

Vegetation Cover (during the time of runoff): The cover on the feeding site will affect to some extent the flow of runoff. However, as runoff often occurs late in the feeding period, hoof action may have reduced stubble effect.

- Forested cover has the least chance of runoff.
- Long crop stubble has the greatest resistance to runoff.
- Medium stubble has less resistance and low stubble the least resistance to runoff.

Flooding Hazard: Flooding is usually predictable from historical records. Beef cattle operations should be environmentally sound for the worst weathers conditions in 25 years. Low land subject to flooding is usually a risk for runoff.

- Sites that never flood may ignore this factor.
- Sites where flooding sometimes occurs should take precaution.
- Sites where flooding often occurs should be avoided as a feeding area.

TABLE 4.2
POLLUTION RISK FACTORS FOR A SEASONAL FEEDING AREA: RUNOFF TO GROUNDWATER

Some of these factors can be influenced by management.

Runoff Risk

- Is runoff expected from the site (consider the factors in Table 4.1)?
- If so, consider the following factors regarding the pollution risk to surface water.

Cattle Density: The number of cattle in an area is an important indication of the amount of manure expected, but must be considered along with the length of the feeding period. Increased density also causes greater snow compaction, resulting in greater frost penetration which may add to runoff risk.

- If there are less than 10 cows per ha (4 per acre) during the feeding period, density is low.
- From 10 to 15 cows per ha (4 to 6 per acre) is considered a medium density.
- Greater than 15 cows per ha (6 per acre) is a high density and manure production is greatest.

Feeding Period: Although a feeding period is rated as high, it must be considered in relation to the cattle density. Density and time must be considered together to assess the risk of manure contamination in runoff water.

- Three months use or less per year is considered short.
- Four to five months use is medium and greater than five months use is long.
- A low cattle density and short feeding period have a low risk of having polluted runoff.
- A high cattle density and long feeding period have a high risk of having polluted runoff.

Slope from the Feeding Area to Surface Water: The slope will determine if runoff from the feeding area may affect surface water.

- Flat ground (less than 2% slope) has the least risk.
- Slight (2% to 10%) or moderate slopes (10% to 15%) have a greater risk.
- Steep slopes (over 15%) have the greatest risk of affecting surface water.

Distance from the Feeding Area to Surface Water: The distance between the feeding site and adjacent surface water is an important factor in runoff risk, but must be considered with slope, field cover, etc.

- Distances greater than 60 m (200 ft) have the least risk.
- Distances from 30 to 60 m (100 to 200 ft) have increased risk.
- Less than 30 m (100 ft) have the greatest risk (and don't comply with the Code).

Type of Runoff Flow: The type of flow from a feeding area can affect the risk of pollution to surface water but should be considered with slope and distance to the surface water.

- Dispersed flow runoff has the least risk.
- Moderately concentrated flow runoff has increased risk.
- Channelled flow runoff has the greatest risk of affecting surface water.

Watering Location: How and where cattle access water should be considered in assessing risk to surface water pollution.

- Livestock waterers properly located with cattle having no access to natural water sources have the least risk.
- Livestock waterers with cattle also having access to natural sources have slightly increased risk.
- Natural sources that have developed sites have greater risk.
- Undeveloped natural sources would have the greatest risk of surface water pollution.

Runoff Containment: Where runoff is expected it should be contained on-site to protect surface water. If runoff will pond, it should be considered for potential pollution to groundwater (Table 4.3).

- Is there on-site containment of runoff (i.e., berms or diversion to crop land)?

TABLE 4.3
POLLUTION RISK FACTORS FOR A SEASONAL FEEDING AREA: RUNOFF TO GROUNDWATER

Some of these factors can be influenced by management.

Runoff Risk

- Is runoff expected from the site (consider the factors in Table 4.1)?
- If so, consider the following factors regarding the pollution risk to groundwater.

Cattle Density: The number of cattle in an area is an important indication of the amount of manure expected, but must be considered with the length of the feeding period. Increased density also causes greater snow compaction, resulting in greater frost penetration that may add to runoff risk.

- If there are less than 10 cows per ha (4 per acre) during the feeding period, density is low.
- From 10 to 15 cows per ha (4 to 6 per acre) is considered a medium density.
- Greater than 15 cows per ha (6 per acre) is a high density and manure production is greatest.

Feeding Period: Although a feeding period is rated as high, it must be considered in relation to the cattle density. Density and time must be considered together to assess the risk of manure contamination in runoff water.

- Three months use or less per year is considered short.
- Four to five months use is medium and greater than five months is long.
- A low cattle density and short feeding period have a low risk of having polluted runoff.
- A high cattle density and long feeding period have a high risk of having polluted runoff.

Distance from the Feeding Area to Groundwater: These distances must be considered with the soil type of the feeding site to assess the risk to groundwater. Shallow groundwater combined with high infiltration soil (such as sandy or gravelly soils) is likely a high risk. If the feeding site is frozen when runoff occurs this risk factor will be of greatest concern only in ponding areas after the ground thaws. The distance down through the soil to groundwater will affect the risk.

- Sites with distances greater than 3 m (10 ft) have the least risk.
- Sites with distances between 1-1/2 and 3 m (5 to 10 ft) have a greater risk.
- If groundwater is less than 1-1/2 m (5 ft) below the site, the greatest risk occurs.

Infiltration: Runoff can be expected to pond behind berms and other restrictions. The soil type must be considered to assess the risk of this contaminated water infiltrating into groundwater.

- If runoff ponds, the soil type affects the infiltration rate and effect on groundwater.
- Clay soils will have the least infiltration, loam soils a moderate amount, and sandy or gravelly soils the greatest infiltration.

Distance from the Ponding Site to Surface Water: The distance between the ponding site and adjacent surface water often relates to the presence of groundwater.

- Distances greater than 60 m (200 ft) have the least risk.
- Distances from 30 to 60 m (100 to 200 ft) have increased risk.
- Less than 30 m (100 ft) risk is greatest.

Ponding Site Containment: The use of an impervious layer under the pond may be warranted for sites where the ponding of runoff occurs on high infiltration soils.

- If the pond is contained by an impervious layer, the risk is low.
- This layer may be clay, a liner, or other material known to prevent infiltration.

EXAMPLE 4.1
SIZING FEEDLOT (CONFINED LIVESTOCK AREAS) RUNOFF COLLECTION BASIN

What volume should a runoff collection basin (with settling basin) be for a 11,150 m2 feedlot in Kamloops that feeds cattle for six months.

1. From Table 4.4, the precipitation coefficient for Kamloops for a six month feeding period can be extrapolated from the five and seven months coefficient to be 40.91
2. This coefficient means 40.91 m3 of basin are required for each 1000 m2 of feedlot area.
3. Total basin volume = 40.91 x 11,150 m3/1000 m3 = 456 m3
4. The settling basin surface area = 2-1/2% x 11,150 m2 = 278.8 m2
5. If the settling is made 0.6 m deep; volume = 278.8 x 0.6 = 167 m3
6. The remaining volume is the main basin = 456 - 167 = 289 m3

This feedlot will require a total runoff collection basin volume of 456 m3 (16,100 ft3) comprised of, a settling basin of 167 m3 (5,900 ft3), and a main collection basin of 289 m3 (10,200 ft3).

TABLE 4.4
PRECIPITATION COEFFICIENT(a) FOR SIZING RUNOFF COLLECTION BASINS

Location	Precipitation Oct-Feb (5 mo)	Coefficient Oct-April (7 mo)	Location	Precipitation Oct-Feb (5 mo)	Coefficient Oct-April (7 mo)
Abbotsford	254.03	310.35	Lillooet	57.62	64.00
Agassiz	258.83	315.81	Merritt	50.48	56.64
Aldergrove	278.33	335.53	Mission	261.67	319.31
Armstrong	70.88	80.78	Nanaimo	198.48	235.44
Blue River	146.76	176.46	Nelson	103.86	123.44
Burns Lake	62.45	71.47	Oliver	49.09	58.11
Castlegar	100.97	125.17	Osoyoos	55.85	65.53

Chilliwack	281.90	338.00	Penticton	44.37	53.83
Courtenay	259.52	300.44	Pit Polder	376.46	457.86
Cranbrook	58.72	68.62	Port Alberni	352.94	423.56
Creston	80.99	95.51	Prince George	83.76	96.96
Dawson Creek	58.50	67.52	Princeton	63.86	71.34
Duncan	210.08	243.08	Quesnel	70.89	81.89
Enderby	74.37	86.25	Saanichton	156.21	180.41
Falkland	66.12	77.34	Salmon Arm	78.31	91.51
Fort St. John	57.56	67.90	Smithers	81.55	91.01
Grand Forks	66.19	78.95	Surrey	219.89	268.29
Hope	309.81	369.65	Terrace	239.52	273.18
Kamloops	38.38	43.44	Vernon	58.49	68.39
Kelowna	49.69	60.25	Willians Lake	41.99	50.13
Keremeos	42.35	50.27	White Rock	184.22	221.28
Langley	242.00	293.92			

(a) The precipitation coefficient is the m3 (ft3) volume of collection basin for each 1000 m2 (305 ft2) of area contributing to runoff for the period of time listed.

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Environmental Guidelines for Beef Producers

5: Water

This section discusses environmental concerns in supplying livestock water using livestock waterers and natural sources. On grazing and seasonal feeding areas livestock are allowed access to natural sources (under certain conditions). Access to natural sources from confined livestock areas, such as feedlots, is not allowed.

The following information relates to environmental concerns. For other water development information see the BCMAF publication **BC Livestock Watering Manual** listed in Appendix F, Reference Material. Remember that a water licence is required for surface water use in BC. An approval is also required for any work in or about a stream. The licence or approval is available from BC Ministry of Environment, Lands and Parks (BCMELP).

The Code of Agricultural Practice for Waste Management defines three types of land use areas (see Section 4, Land Area Management or Appendix C) and water access differs for each land use area.

- **Grazing Area.** Beef cattle may have access to natural watercourses.
- **Seasonal Feeding Area.** Beef cattle may have access to natural watercourses under certain conditions.
- **Confined Livestock Area.** Beef cattle are not allowed access to natural watercourses.

5.1: Livestock Waterers

Livestock waterers can provide water to cattle with very low risk of pollution. There is usually some risk of polluting when using natural sources. Therefore livestock waterers are the preferred method of watering cattle (where installation is feasible).

Depending on the site and location of the livestock waterers, consider these points:

- **Cost.** Materials and installation may be costly but justified by the advantages.
- **Pumping Energy.** Unless gravity flow is possible, many sites will require the water to be pumped. These sites may be remote from standard energy grids (electricity or natural gas).
- **Heating Energy.** The winter use of livestock waterers means they must be frost proof. Which requires either energy at the site or specially constructed livestock waterers.
- **Alternative Energy.** Both pumping and heating energy can be supplied by alternative energy sources. These non-traditional sources are discussed in the BCMAF BC Livestock Watering Manual and other publications listed in Appendix F, Reference Material.

Providing water to livestock with livestock waterers has some definite advantages:

- **Choice of Location.** Livestock waterers do not restrict the selection of feeding sites.
- **Livestock Control.** Livestock activity can be influenced.
- **Protection of Natural Sources.** Stream and foreshore conditions may be improved, allowing vegetation growth and reducing erosion concerns.
- **Winter Use.** Livestock waterers can be frost free for a convenient all-winter water supply.

Where livestock waterers are chosen, the following points should be considered to ensure environmentally sound installations:

- Locate livestock waterers so manure that may accumulate cannot contaminate watercourses. This may require a set back to a watercourse similar to the feeding setback (30 m or 100 ft).
- Cattle should be fed away from livestock waterers, encouraging manure distribution.
- Install livestock waterers on a firm base, preferably concrete.
- Use a concrete apron or other suitable hard surface material around the livestock waterer to prevent soil damage and muddy conditions.
- Install livestock waterers to eliminate faecal contamination of the waterer and the attendant problems of disease and parasite transmission.
- Where required, ensure adequate drainage for spillage or waterer overflow. If the water overflow becomes contaminated it must be handled as outlined in Seasonal Feeding Area Management or Runoff Control and Collection under sections

4.2 or 4.3 respectively.

Be prepared for the following ongoing maintenance:

- Check float setting for proper water level (reduce spillage).
- Check for system leaks.
- Clean bowls regularly.
- Check power supply (when used).
- Check thermostats (when used).

Flow Through Livestock Waterers. Whether used for summer or for frost free winter use, flow through livestock waterers are very practical. They are most commonly used when a gravity pressured water supply is available. The flow through principle is used for winter frost proofing. The heat available in the supply water flow is used to offset the heat loss from the livestock waterer by adjusting the flow passing through it. The main concerns are:

- The flow must be able to be stopped when not required.
- The outlet flow must be piped away from the livestock waterer.
- The outlet must be sized correctly to avoid spillage at the livestock waterer.
- The outlet flow must be secure from contamination (i.e., is not allowed to surface run but is piped away from the watering area).

Cow-Powered Livestock Waterers. These livestock waterers are potentially useful on grazing areas or anywhere energy is not available. They contain a diaphragm pump operated by a lever that the cow pushes with her nose in trying to reach the water bowl. Approximately one litre of water is delivered per stoke. The lift capacity of these pumps is up to 8 m (27 ft), (Note: this lift is reduced by elevation, friction, suction and other losses). Water can alsobe pumped horizontally depending on friction losses of the piping. A foot valve is used to ensure pump priming. The manufacturers estimate one livestock waterer can be used for 40 to 50 cows. Livestock will require some training to use this waterer.

Solar Powered Water Pumping. Another option in supplying pumped livestock water is the use of solar energy powered water pumps. These are most appropriate when the common energy sources are either not available (utility electricity) or expensive and inconvenient to use (gas and diesel fuel).

Photovoltaic solar panels that convert sunlight directly to DC electricity have been demonstrated to be practical for BC conditions. A number of systems are currently operating on Crown range and

private grazing areas. System design and other information is outlined in the BCMAF publication BC Livestock Watering Manual. More detailed photovoltaic water pumping information can be obtained from the Soils and Engineering Branch, BCMAF.

Flow of Stream Pumps. Small flow pumps that are powered by flowing stream water are available that may be useful to pump livestock water. These are generally untested in BC at this time but are used successfully in other countries. Flow rates are low but the pumping action is continuous 24 hours a day. Water storage may be required to meet the peak flow requirements when cattle drink.

5.2: Natural Water Sources

When livestock water directly from creeks or lakes their presence can affect the water resource. The fishery, recreational, aesthetic and other values of the water resource must be maintained. This does not mean denying cattle the use of the water but that stockmen must use environmentally responsible methods to water the cattle.

Impact on Watercourses. The impacts to water-courses from the unrestricted access by cattle varies according to the livestock intensity. This is recognized by the Code in the designation of three types of feeding areas and defining their respective access to watercourses. These impacts can result in a range of concerns depending on the severity of the impact and on the sensitivity of the watercourse. Management practices can reduce the impact to watercourses.

The following concerns are the disadvantages when watering from natural sources:

- Direct deposit of manure and urine into the water while drinking can have a number of harmful effects. Increasing the concentrations of nutrients, suspended solids, and bacteria in the watercourse can result in: contaminate water; harm or destroy fish and/or fish spawning grounds; increase algae growth; and destroy aquatic organisms.
- Deposit of manure onto low land that is seasonally flooded, by high water can wash contaminates into the water course.
- Trampling of streambanks or lake foreshore immediately adds to the silt content of the water affecting fish stocks. Trampling can also destroy streambank vegetation which is necessary to prevent erosion during freshet flows. Erosion affects both the fish stock and the adjacent farm or grazing land.

Reduction of Impacts. Proper development of a watering site on a

natural watercourse will reduce or eliminate all these impacts. This is often the case when livestock waterers are installed (see Section 5.1 Livestock Waterers). Undeveloped, natural sites can be made more environmentally sound if:

- Loitering is discouraged by feeding and salting well away from the water.
- Access to the watercourse is controlled by fencing.
- A gradual sloped access is chosen which can be cleaned before freshet.
- Bank protection is added such as rip rap, gabions or logs (BCMELP approval required)
- Gravel is added to improve footing in poor soils. (BCMELP approval required)

Figure 5.1 illustrates a well developed creek watering site. For more information on developing watering sites see the Engineering Factsheet **Ground Stabilization Using Geogrids – Improving Cattle Access to Water (641.270-1)** listed in Appendix F, Reference Material.

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Environmental Guidelines for Beef Producers

6: Feed

This section outlines the environmental aspects of feed handling and storage, and the feeding of beef cattle. Emphasis is on preventing feed waste and feed losses from contaminating natural water sources.

6.1: Feed Handling

Environmental concerns relating to feed handling are mainly due to wasted or lost feed. Feed is wasted or lost in the field, from storage and at the feedbunk. To ensure against surface or groundwater contamination consider the following:

- Keep feed contained during transport.
- Clean up feed spills before they can affect any water source. This will reduce odours and rodent activity.
- Provide all weather roads between feed receiving, handling, storage and feeding areas.
- Have sufficient space for large transport vehicles to manoeuvre.

6.2: Feed Storage

Beef cattle feed should be stored to prevent contamination of water sources. Most contamination is caused by leachate or runoff from the storage facility.

Hay Storage – Low Rainfall Areas. Consider the following points for hay storage structures in low rainfall areas.

- Choose a well drained dry site not subject to seasonal water flows (divert off-site runoff away from the site).
- Ensure contaminated runoff from the site is controlled and handled (see Seasonal Feeding Area Management in Section 4.1 and Runoff Control and Collection in Section 4.3).
- Cover hay with a tarp or a pole shed (usuallyworthwhile in

reduced feed losses) and provide for roof runoff control using gravel splash pads.

- Provide all season access for transport equipment.
- Lay out the site so as to allow good cleanup of spillage.

Hay Storage – High Rainfall Areas. Consider the points listed for low rainfall areas plus the following:

- Covered hay storage is usually necessary to reduce feed losses. The leachate from the feed is the concern and covered storage reduces both feed losses and environmental risks.
- Pole barns must have runoff controlled from the roof with eave troughs to ensure drainage away from the structure.

Silage Storage – Low Rainfall Areas. Silage juices are a greater pollution concern than manure. If silage juice is produced, they should be collected and add to the manure storage. Consider the following points for silage storage structures in low rainfall areas.

- Choose a well drained site not subject to seasonal water flows (divert off-site runoff away from the site).
- Open pit storages are suitable in these areas.
- If silage is put up wet or if silage juices will form, a floor of concrete or other impervious material is required.
- Silo floors are designed to drain forward to the open end to avoid trapping rainwater and silage juices. This flow must be diverted away from watercourses and onto adjacent fields, etc. Large silos may require this flow to be drained to a liquid storage facility.

Silage in plastic bags should be stored on sites similar to those indicated above with the following additional considerations:

- The base should be free of sharp rocks.
- The site should be fenced to deter livestock and wildlife.
- The site should be kept free of ruts and weeds to discourage vermin.
- Where required, the site should be baited to control vermin.
- Bird damage, usually to the upper surfaces of bags which does not allow juice leakage, can cause forage spoilage.

It should be noted that this storage method can result in a large amount of waste plastic material. This creates a secondary concern relating to the disposal of the plastic. See Section 12.9, Plastics.

Silage Storage – High Rainfall Areas. Consider the points listed for low rainfall areas plus the following:

- Covered pit storages may need eave troughs for roof runoff control. Concrete or other impervious floor material should be used to collect silage juice with the floor extending past the front of the silo to act as a pad to manoeuvre on.

Grain Storage -- All Areas. Grain should be stored in covered, vermin proof structures such as free standing wood or steel bins or temporary areas of barns. These structures can provide good environmentally sound containment.

6.3: Feed Processing

Good storage and processing for feed and feed ingredients are a sound investment. Adequate facilities and proper management can help avoid pollution and reduce losses due to spoilage, insect and rodent damage, and fire from spontaneous combustion.

Before building new feed storage facilities, a complete storage and handling system should be designed to meet both present and future requirements. When designing a storage facility mechanization needs to be considered. Choose a building site with good drainage, preferably elevated and easily accessible. Divert roof water and any other clean water away from the site.

All feed material for processing, processed and stored feed must be contained. Uncontained feed can contaminate surface or groundwater. If there is contaminated runoff that could cause pollution, it must be collected and stored.

To reduce odours, rodent activity and contaminated runoff, clean up spilled feed as soon as possible.

Consider locating the feed processing and handling centre in an area that will allow access of large vehicles. Sufficient setback from neighbours is important due to the increased noise level of operation, dust, traffic and the threat of a fire.

For more information on feed processing, handling and storage, see the publication **Planning Grain-Feed Handling (MWPS-13)** listed in Appendix F, Reference Material. Information on obtaining this publication is available from the BCMAF, Soils and Engineering Branch office in Abbotsford.

6.4: Feeding Beef Cattle

Feeding losses have been estimated to range from 2 to 5% for forage in feeders, and from 10 to 50% for forage fed on the ground. While these losses are costly to a beef cattle producer, they can also be of

concern environmentally.

Feeding Hay, Silage or Grain. Hay fed on the ground is subject to the greatest losses. Slant bar and tombstone feeders are designed to reduce losses due to dropped hay as cattle pull back from the feeder. However, some losses still occur. As manure will build up around feeders, consider where feeders are located. Permanent feeders on a Seasonal Feeding Area require approval from BC Ministry of Environment, Lands and Parks before using.

Silage and grain are generally fed into a feeder or feed bunk; however, losses may occur from cattle dropping feed.

Consider the following points when selecting a feeding area:

- For seasonal feeding areas choose a site that allows for feeding at a setback distance from watercourses greater than 30 m (100 ft).
- For confined livestock areas choose a site where cattle are fenced 30 m (100 ft) away from watercourses.
- Choose a site that is well drained and not subject to seasonal flows or flooding.
- Clean up spilled feed periodically.
- Clean up wasted feed in the feeders periodically.
- Develop the water supply as outlined in Section 5, Water.
- Handle runoff from the feeding area in such a manner that pollution does not occur. See Seasonal Feeding Area Management in Section 4.2 and Runoff Control and Collection in Section 4.3.

Whether feeding in a seasonal feeding area or a confined livestock area (i.e., overwintering or feedlot) the following points should be considered to prevent water contamination from feed:

- Keep the feeding site, feeder or feedbunk clean of wasted feed.
- Control runoff onto and off of the feeding areas and the feed storage area.

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7: Beef Cattle Structures

This section is concerned with structures typically found on beef cattle ranches and feedlots. Recommendations are made for good practices in establishing and managing new facilities and expanding existing ones. The information presented concerns locating and erecting structures to minimize their environmental impact. Other detailed construction information is available in publications and plans identified in Appendix F, Reference Material.

7.1: Planning Beef Cattle Structures

The importance of planning structures to reduce environmental impacts cannot be over emphasized. Effort spent in carefully selecting a building site or livestock holding area will pay off in fewer problems, such as manure handling, vehicle access and future expansions. When planning a structure for beef cattle consider these goals:

- provide for the required features such as space, shelter, feed, water, waste management and livestock handling;
- adapt them to the natural features of the site considering the possible environmental impacts;
- organize them for efficient and easy operation; and
- consider future possibilities such as expansion requirements, or more restrictive environmental requirements.

SITE PLANNING FACTORS

Beef cattle structures should be planned. Site planning will help whether a large commercial feedlot or only a calf shelter, feeder or fence are constructed. Site selection should include the following factors:

- For structures that contain manure, allow adequate setbacks so as not to pollute. The Code requires a minimum 15 m (50 ft)

from a watercourse and 30 m (100 ft) from wells or domestic water intakes. Greater distances may be required in some situations.

- Comply with local government bylaws (municipal or regional district).
- Comply with Federal and Provincial siting requirements.
- Give preference to locations within the Agricultural Land Reserve and areas zoned for agriculture.
- Ensure there is sufficient cropland to receive the agriculture wastes for crop production. See Section 9, Land Application of Manure.
- Consider the following natural features of the site:
  - Topography. Slopes require excavation for a level building site. This can change runoff flow and cause snow drifts.
  - Soil Types. When disturbed, some soil types are more susceptible to erosion.
  - Access. Ensure a well drained, all season access to a site so animals can be moved, manure removed, feed hauled, employees can access the site, etc.
  - Drainage. Drainage is influenced by soil type, topography, rainfall and snowmelt runoff. Do not build structures on areas subject to seasonal water flows or flooding. Avoid low areas where runoff will collect or where flooding from nearby lakes or creeks may occur.
  - Off-site Runoff Control. Off-site clean snowmelt or rainfall runoff should be diverted away to reduce on-site runoff concerns.
  - On-site Runoff Control. On-site contaminated snowmelt or rain must not be allowed to run to natural watercourses such as creeks or lakes or soak into the ground if it will cause pollution.
  - Terrain and Vegetation. Take advantage of the terrain and vegetation to act as wind buffers and as visual screens. Trees or natural mounds may be used to effectively screen manure storage areas for example.
  - Prevailing Winds. In conjunction with natural features (trees) wind can dilute odours. Consider prevailing wind directions to minimize conflicts with neighbours or the general public.
  - Exposure to Sun. South facing sites will receive more winter sun that can warm livestock, dry out wet areas and

thaw earlier.

- Visual Impact. While not as important environmentally as the previous concerns, consider how the structure will integrate with the natural features of the site.

This planning process is always a matter of compromise. Strive to achieve maximum site performance with acceptable environmental impact. These planning points will be considered in the following sections on housing and handling structures for beef cattle.

7.2: Structures for Housing Beef Cattle

Beef cattle are not generally intensively housed. Many structures act as a seasonal shelter only. Consider the following points where structures are used. Items that differ depending on the rainfall of the site are discussed separately.

Common housing structures include feedlots, calving barns, calf range shelters and covered feeding barns. The following are important points to consider if building a new structure or expanding an existing one.

- Consider the factors discussed in Section 7.1. Planning Beef Cattle Structures.
- Design and construct structures in accordance with the **Canadian Farm Building Code** (see Appendix F, Reference Material).
- Have gravel splash pads at the base of the wall for erosion control where roof runoff occurs (see figure 7.1).
- Have adequate perimeter drainage to remove roof and surface water away from the building in an uncontaminated state.
- Ensure any contaminated runoff from the site is contained and cannot flow into surface or groundwater. Runoff control is one of the most important considerations (see Seasonal Feeding Area Management in Section 4.2 and Runoff Control and Collection in Section 4.3).
- Ensure manure accumulations can be removed for field spreading or to storage. Consider the removal method and equipment size (see Section 9, Land Application of Manure). Also, consider the manure storage requirements (see Section 8, Manure Storage).
- Wood in contact with the ground should be treated, preferably pressure treated, with a non-leaching chemical such as Chromated Copper Arsenate (CCA). This is the common green

tinted wood treatment. Do not use treated wood of any sort for feed bunks. Cover treated wood walls of horizontal silos where contact with silage is possible.

- Use concrete as an alternative to treated wood where practical.

VENTILATION

Beef cattle buildings such as calving sheds, cattle shelters in feedlots and total confinement beef cattle buildings require ventilation. A good ventilation system will:

- Remove dust, harmful gases and odours from the buildings.
- Maintain an adequate supply of fresh air within the building.
- Control the temperature and humidity of the air inside the building.

When properly designed, natural ventilation in single storey uninsulated barns is usually adequate. Ridge ventilators and perimeter ventilation inlets provide the necessary air exchange. With care, a minimum of draft discomfort to the livestock can be achieved (see Figure 7.2 for typical roof ridge vents).

Warm, insulated barns and barns with low ceilings will normally require supplemental ventilation supplied by fans. When fan ventilation is used, low level winter ventilation should be on a continuous basis. Higher ventilation levels required in the summer may be controlled by thermostats.

Exhaust fans should be located to direct their discharge away from nearby residences and public places. This will help to avoid nuisance conditions.

To prevent backdrafts, shutters should be installed over exhaust ports. In buildings where dust and odour levels can be high, hoods on exhaust ports to direct the discharge down toward the ground may be beneficial. In all cases, hoods or protective flaps should be installed on all ventilation ports to prevent the entry of rain and snow (see Figure 7.3). For detailed ventilation information refer to the BCMAF **Ventilation Handbook** listed in Appendix F, Reference Material.

7.3: Structures for Handling Beef Cattle

Beef cattle are generally handled in outdoor, open facilities for either loading out or working in a chute or squeeze. As with housing structures, control of runoff, manure and drainage are important environmental considerations. Consider the following points:

- Site structures a minimum of 30 m (100 ft) away from any

watercourse.

- Consider the planning factors discussed in Section 7.1.
- Construct to the Canadian Farm Building Code where applicable.
- Select a well-drained site accessible by an all season road.
- Divert clean off-site runoff away from the handling area.
- Contain contaminated site runoff and store if required.
- Plan for manure removal and storage.
- Ensure proper disposal of used veterinary supplies. See Section 12.7, Farm Medical Wastes.
- Provide a livestock waterer in all holding pens (when cattle are held overnight or longer).

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8: Manure Storage

Beef cattle manure is a valuable by-product of ranch and feedlot operations. However, to realize the potential value of the manure and to avoid pollution problems, there is a need for a well planned manure storage system. This section deals with sizing a manure storage facility, stockpiling manure, and manure storage structures.

Beef manure is normally only collected and stored from cattle fed in confined livestock areas. All manure storage systems should be evaluated to ensure pollution is not occurring. The facility must meet the requirements in the Code of Agricultural Practice for Waste Management.

A storage facility (see Figure 8.1) is a permanent structure or location designed and operated to contain manure and runoff in an environmentally sound manner. The facility must be sized to hold wastes until they can be used as a fertilizer. Timing and amount of manure to apply on cropland is explained in Section 9, Land Application of Manure.

Field storage is a temporary field location for manure storage where the manure is stored just before spreading on crop land. Only solid manure (manure with more than 20% solids) may be stored in a field storage. Field storages are not meant to replace storage facilities. They should only be used in the spring, summer and early fall. Field storage during the winter is not recommended due to risk of polluting surface and groundwater. In areas of high winter rainfall, 600 mm (24 in) precipitation during the seven months of October to April, field stored manure must be covered e.g., tarped (A requirement of the Code). Field stored manure must not be located in low areas that are subject to flooding.

8.1: Manure Storage Capacity

Storage of manure is required during the times of the year when

manure cannot be applied to cropland due to the risk of causing pollution. Ideally, a manure storage facility should be sized to contain six months (180 days) of manure production. This would allow a beef cattle producer to use manure as an organic fertilizer with the least chance of causing pollution. Table 8.1 suggests the minimum storage duration required for various areas of the province. The suggested manure storage duration in Table 8.1 vary depending on location in the province, soil type, soil temperature, and crop grown. Variations in storage requirements within a region depend on soil type and local weather. Weather affects the ability of the producer to get onto the land to spread manure.

Manure storages should be designed taking into account the highest rainfall that has occurred over a 25 year period. In the south coastal area, most fields will be too wet to allow for spreading during late fall, winter and spring. To obtain an estimate of the manure storage capacity required for manure from cattle in confined livestock areas:

Multiply the suggested daily manure storage per animal found in Table 8.2 by the average number of animals on the farm to determine daily manure storage volume required for each size of animal.

Determine the total daily storage volume by adding together the daily storage volume requirements for each size of animal.

Multiply the total daily storage volume by the required storage duration found in Table 8.1 to obtain the total storage capacity required.

This calculation is shown in example 8.1.

8.2: Solid Manure Stockpiles

Long term storage by stockpiling manure directly on the ground is not recommended where pollution might occur. Stockpiling manure on the ground in areas of high rainfall or high watertables is likely to pollute. Where stockpiles are being used to store manure, these stockpiles should:

- be located at least 30 m (100 ft) from any water source or well;
- be covered with tarps in areas of high precipitation or where runoff might occur; and
- be managed so pollution hazards are not created. If problems do occur, stockpiles may have to be replaced by a contained type of manure storage structure.

8.3: Manure Storage Structures

Runoff and manure storage structures, whether an earthen basin or a reinforced concrete tank, require similar siting and sizing considerations. These structures should:

- be located at least 15 m (50 ft) from any watercourse;
- be located at least 30 m (100 ft) from wells or domestic water intakes;
- be sized to provide enough storage that will enable the operator to spread manure during times when manure runoff to surface water will not occur, and when crop uptake of the nutrients will occur;
- be either open or covered as required by the local precipitation expected;
- be structurally sound (consider professionally engineered designs for both earthen and concrete structures);
- be of watertight construction;
- for manure storage, be located, or the land graded, so that clean surface runoff from adjacent areas is excluded;
- for contaminated runoff storage, be sized and located to contain all of the runoff expected from local climatic conditions (the worst precipitation in 25 years); and
- be adequately fenced to prevent the accidental entry of humans, animals or machinery.

The following discussion provides details on storage structures for various types of manure.

SOLID MANURE STORAGE STRUCTURES

Open type manure storage structures may be suitable in low precipitation regions of BC. If a problem arises from this type of storage an enclosed structure may be required. Open type manure storages should:

- meet the points listed in 8.3 for Manure Storage Structures;
- have a base of concrete or other impervious material and a curbed sidewall on at least two sides (illustrated in Figure 8.2); and
- where possible be located out of sight and downwind from public places and neighbouring residences.

In areas of high precipitation be adequately roofed to prevent the manure from becoming a semi-solid or liquid type manure (see Figure

8.1).

SEMI-SOLID MANURE STORAGE STRUCTURES

Manure scraped from total confinement barns, covered yard areas and some feedlots, may be handled as a semi-solid. Semi-solid manure storages are designed to permit tractor access as illustrated in Figure 8.3. Both earthbank and concrete storages are used.

Earthbank Storages. These are very similar to the solid manure storage structures except with the ability to contain manure that contains more liquid. Earthbank semi-solid manure storage should:

- meet the points listed in 8.3 for Manure Storage Structures;
- have a concrete floor (or other impervious floor), curb and access ramp to allow easy access by a tractor and manure spreader; and
- if constructed in other than clay soils, be lined with an impervious material where seepage may be a problem.

Concrete Storages. Semi-solid manure storages built with concrete should:

- meet the points listed in 8.3 for Manure Storage Structures;
- have reinforced concrete walls to contain the manure;
- have a concrete floor which is sealed to the walls to provide a manure tight storage;
- in areas with high watertables, be constructed entirely above ground to minimize seepage of groundwater into the structure;
- be roofed to keep out rain and snow in areas with high annual or seasonal precipitation;
- if roofed, be well ventilated to prevent the accumulation of hazardous gases in the head space area and to aid the drying of stored manure;
- have access doors constructed of tight tongue and groove pressure treated timber, or equivalent. Seepage, if any, should be contained by diversion onto a grassed infiltration area or by draining into a catchment pond or an underground concrete storage tank; and
- if fitted with a ramp, have guard rails and safety stops on the ramp to prevent a tractor from being buried in the manure.

In colder and drier regions of the Province, an uncovered, three-sided concrete storage structure may be suitable. These structures should:

- have reinforced concrete side-walls on three sides of the structure;

- have a concrete floor, sloping downward from the open side, which is sealed to the walls to provide a manure tight storage; and
- have provisions for control of seepage, if any, so as not to create a pollution hazard.

LIQUID MANURE STORAGE STRUCTURES

Liquid manure and contaminated runoff can be stored in earthbank storages, or covered or uncovered concrete storages. When manure handledas a liquid there is more odours compared to manure handled as a solid.

Earthbank Storages. Earthen lagoons for liquid manure or runoff storage should:

- meet the points listed in 8.3 for Manure Storage Structures;
- be constructed with a pumping dock to permit access by PTO driven pumping equipment; and
- if constructed in other than clay soils, be lined with an impervious material where seepage may be a problem.

Concrete Storages. Where liquid holding tanks are employed for storage of beef wastes, these tanks should:

- meet the points listed in 8.3 for Manure Storage Structures;
- be constructed of concrete with a rated strength of 20 mpa (3,000 psi) or greater (preferable 35 mpa 5,000 psi);
- if very large, have cross wall and/or baffles to facilitate agitation prior to emptying;
- if unroofed, be sized to allow for precipitation storage (designed for highest precipitation during a 25 year period);
- if constructed entirely or partially above grade level:
  -- have tight fitting closures on loading and/or unloading ports; and
  -- be equipped with a manure level indicator that can be read from the ground;
- if constructed with less than 1.5 m (5 ft) of the wall above grade level, and not covered, be adequately fenced to prevent humans, farm animals, and machinery from accidentally falling into the tank;
- if constructed entirely below grade level, and covered:
  -- have access ports covers with a minimum of 20 kg (40 lb) steel covers or equivalent childproof covers; and
  -- have adequate surface drainage around the tank to prevent the entry of surface water; and

- if constructed below slotted floors within a beef cattle building:
  -- be designed to allow 300 mm (1 ft) of freeboard space at the top of the tank; and
  -- be adequately ventilated to prevent the accumulation of hazardous gases. Gases may accumulate in the head space area or in the area of animal occupancy.

TABLE 8.1
SUGGESTED MINIMUM MANURE STORAGE DURATION

Location	Days
South Coastal	125 - 210
South Okanagan	140 - 180
North Okanagan & Thompson	155 - 210
Remainder of Province	168 - 210

TABLE 8.2
AVERAGE DAILY MANURE PRODUCTION AND SUGGESTED STORAGE

Beef Type	Manure as Excreted kg/day/animal	Suggested Storage no bedding	litres/day/animal with bedding
Cow or Bred Heifers	32	28	34
Calves to 230 kg	13	14	17
Yearling to 340 kg	20	20	23
Heavy Feeders to 500 kg	29	28	34

To convert to Imperial Units:

1 kg = 2.2 lb
28.3 litres = 1.0 ft3

EXAMPLE 8.1
CALCULATION OF STORAGE REQUIRED FOR BEEF

CATTLE MANURE

What size of a manure storage facility needs to be built for a proposed 1000 head (heavy feeder) feedlot? The cattle are housed in a Wedge Pack barn (scraped daily) in the Fraser Valley. The operator wants six month storage.

Daily manure volume complete with bedding	= Table 8.2 value x 1,000 animals
	= 34 litres/animal x 1,000 animals
	= 34,000 litres/day
Suggested storage period	= 180 days
Minimum storage capacity	= 34,000 litres/days x 180 days
(Table 8.1)	= 6,120,000 litres or = 6120 m3
Conversion to cubic ft	= 6,120 m3 x 35 ft3/ m3
	= 214,000 ft3

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9: Land Application of Manure

Animal manure is a valuable source of plant nutrients and organic matter. Manure contains a vast array of organisms that add to the biological activity in soils. If not managed with sufficient care, manure can be a major source of pollution. Poorly managed manure will contribute to contamination of surface and/or groundwater. Maximizing the fertilizer value of manure also minimizes the environmental impacts.

This section provides information on: composition and benefits of manure, factors affecting water contamination from manure, practical guidance on land application, manure application rates and manure spreading equipment.

9.1: Composition and Benefits of Manure

Manure management systems consist of various components including manure collection, storage, transport and land application. Manure is a dynamic organic material continually undergoing biological and chemical changes. Each phase of management may result in losses and changes to the beneficial nutrients in the manure. Therefore, the values of manure as a fertilizer depends on the quantity and form of nutrients present when it is applied to land.

Table 9.1 shows the average amount of nutrients found in typical beef cattle manure. This table can be used by crop producers who are using beef cattle manure as an organic fertilizer. They can determine how much of manure is needed to give a desired application of nutrients.

VALUE OF NITROGEN (N) IN MANURE

Nitrogen in manure exists in two forms, inorganic and organic. Inorganic nitrogen (ammonia) is the simple, soluble form that plants can use. After application to land, ammonia is converted by soil bacteria to a nitrate (NO_3) form. Nitrate can be lost from the root zone through leaching or denitrification (loss to the atmosphere). Manure solids also contain nitrogen in the organic form. Until the organic matter is biologically decomposed in the soil, the nitrogen remains unavailable for plant use. Nitrogen in the organic form is desirable since it acts as a reserve in the soil and is slowly released for plant use.

Stored Manure. Solid beef cattle manure loses much of the ammonia in it to the atmosphere (volatilization) while in storage. When the material is eventually spread onto land for crop production, most of the remaining nitrogen is in the organic form and not subject to volatilization. Because of the lack of inorganic forms, the nitrogen compounds in beef manure must be decomposed by soil microbes before they are available to plants. It can be assumed, as a general rule, that 50% of the nitrogen in the manure when applied, is available during the year of application. The rest of the nitrogen becomes available over the next three to five years.

If manure is applied during the fall or winter, it is estimated that up to one third of the nitrogen may be lost. The losses are due to leaching, denitrification and by runoff.

Grazing. Grazing animals deposit manure directly on the land in the form of urine and faeces. The nitrogen content of this manure depends on: size of animal, nitrogen content of the diet and consumption of water. The most significant factor governing the nitrogen content of the manure (especially the amount in urine) is the crude protein nitrogen content of the forage and

other feed sources.

VALUE OF PHOSPHORUS (P) IN MANURE

Research indicates that 50% of total applied phosphorus in manure is available to the crop in the year it is applied. Most of the phosphorus contained in manure is in the organic form. Its availability is dependent on the rate at which soil organisms break down the organic material (mineralization) and release phosphorus.

On land where beef cattle manure has been applied regularly over many years, the phosphorus 'fixing' capacity of the soil is reduced. On such soil, the availability of the phosphorus in manure approaches 100%. Producers should assume manure to be as effective as chemical fertilizer in supplying phosphorus to crops.

VALUE OF POTASSIUM IN MANURE

All potassium in manure is available to the current crop. Soil that regularly receives manure is not often lacking in this nutrient. Grass Tetany can be caused by cattle eating grass grown on soil with excess potassium.

TRACE ELEMENT VALUE

The major fertilizer nutrients of manure are considered to be nitrogen, phosphorus and potassium. However, manure also contains the secondary nutrients sulphur, magnesium and calcium, as well as the micronutrients iron, manganese, boron, chlorine, zinc, copper and molybdenum. The availability of these elements as plant nutrients, varies depending upon the soil type and soil acidity.

VALUE OF MANURE AS A SOIL CONDITIONER

A positive benefit of applying manure to soil is the improvement of the soil physical structure. The decomposition of manure by bacteria contributes to improved aeration, improved permeability, and increased water holding capacity of the soil. Other soil conditioning benefits include pH buffering and an improvement to soils having high salt levels. When using manure as a soil conditioner, application rates must not exceed the nutrient requirements of the crop grown.

9.2: Factors Affecting Water Contamination

SOUTH COASTAL REGION

Soil Characteristics. The proportions of sand, silt, clay and organic matter in a soil determine the water and nutrient holding capacity. In general, soils with a high clay and/or organic matter content have a relatively high capacity to hold water and nutrients in the root zone. Sandy soils, on the other hand, have a low capacity. Therefore, the leaching of nutrients from sandy soils during the winter months is much greater than from more heavy textured soils or soils with a high level of organic matter.Leaching of nutrients from sandy soils could result in groundwater quality degradation.

Drainage. Poorly drained soils become saturated during late fall, winter and early spring. After saturation, precipitation can no longer enter the soil. Therefore, water accumulates on the soil surface and eventually runs off into adjacent ditches or other watercourses. When this happens, materials, such as manure, that have been applied to the soil surface are removed with the water, and degrade receiving waters.

Slope. If water does not infiltrate soil on sloping lands it must run off. If these lands become saturated, runoff is even greater. Material such as manure and nutrient rich soil particles can be eroded and removed with the runoff water. This could contaminate receiving waters, or pond and contaminate ground water.

Nitrate in the Root Zone. The nitrate form of nitrogen is of major concern due to its potential to contaminate drinking water. Nitrate is also the dominant form of plant available nitrogen found in agricultural soils. Most of the nitrate in the root zone in the fall of the year is leached from the soil over the winter months. Where nitrate leaches from soils over sensitive groundwaters or adjacent to surface waters, the nitrate will contribute to water contamination.

Excessive levels of root zone nitrate are found in soils where the spring application rates of manure and fertilizer have been high in relation to the ability of the crop to use the nitrogen. Excessive levels of root zone nitrate are also found in soil where there has been a fall application of manure after the crop is harvested.

Lack of Cover Crops. Permanent grasslands and, to a lesser extent, fall planted cover crops take up soil nitrates (and other nutrients) during fall, winter and early spring. In addition, cover crops keep the soil surface open thereby reducing or eliminating ponding and surface runoff. Bare soil, on the other hand, is susceptible to leaching, surface sealing, ponding and runoff.

INTERIOR REGIONS

Spring Runoff. In the areas of the province where soils are frozen and snow accumulates during the winter months, smowmelt water can runoff the land into adjacent streams or bodies of water. Any manure that has been applied to the land since the previous fall can leave the land with the melt water and contribute to water contamination.

9.3: Monthly Environmental Considerations

JANUARY, FEBRUARY AND MARCH

South Coastal Region. If the land is subject to flooding and/or runoff, no manure should be applied because of the high risk of contamination of adjacent waters. If, however, flooding and runoff is controlled through adequate on farm and regional drainage systems, some manure can safely be applied on grassland or land seeded to an overwintering cover crop. Manure should not be applied to bare land, or to frozen land or land covered with snow where there is a risk of runoff.

Interior Regions. In most cases, manure application cannot be contemplated due to frozen soil and snow cover. If field access is possible, manure application should only be considered if there is minimal chance of runoff during the spring breakup period (see Section 4.2, Seasonal Feeding Area Evaluation for risk assessment).

APRIL AND MAY

All Regions. On seasonal feeding areas collect and spread any build up of manure. On confined livestock areas remove and spread all manure.

On annually cropped land, apply and immediately incorporate the correct amount of manure. On grass land, apply the correct amount of manure. The correct amount of manure will supply the amount of nitrogen the crop removes, as calculated in Section 9.5, Manure Application Rates. Do not attempt to completely fertilize the crop with manure. Excess manure will result in a high rate of nitrate production in the latter part of the growing season and after harvest when nutrient uptake is minimal. Supplement the manure with fertilizer at planting or side dress time.

JUNE, JULY AND AUGUST

All Regions. If manure must be applied, in most cases it can be applied only to grassland due to the presence of actively growing crops on other lands. Manure nitrogen efficiency for grassland can be greatly increased by irrigation immediately following application. Nitrogen

efficiency can also be increased by application of very wet manure slurries (more than 95% moisture content). Application of additional fertilizer nitrogen to grassland should be fine tuned according to the protein content of the forage. Grasses with a protein level of 20% or more have a high probability of nitrate accumulation in the grass. High nitrate grass can be harmful to cattle.

Although manure cannot be applied to annual crops during this period, crops can be supplemented with fertilizer nitrogen. A late spring soil test has been found to be useful in indicating whether a response to added nitrogen is to be expected. The critical range is 20 to 30 kg/ha (18 to 27 lb/ac) nitrate nitrogen in the plough layer (0 to 20 cm or 0 to 8 in). Soil nitrate nitrogen below this range is usually deficient in nitrogen. Soils deficient in nitrogen require supplementation before the crop will achieve sufficient yield. Soil above this range will generally supply all the crops' nitrogen requirements.

SEPTEMBER AND OCTOBER

South Coastal Region. This is the most critical time of the year if manure is to be managed in an environmentally sound manner. On annually cropped land, crops have reached maturity and nutrient uptake has ceased. Soil temperature and moisture conditions are near optimal for formation of nitrates in the soil. Therefore, any added manure will only further contribute to the problem of fall nitrate levels and overwinter leaching.

If manure must be applied during this period, it should be restricted to grasslands that are well drained and not subject to flooding or runoff. Grasses are still actively growing and their roots will capture much of the nitrate and prevent leaching. Even so only 40% of the annual allowable application should be spread in the fall and winter periods.

On other lands, winter cover crops must be planted before any application should be contemplated. Only spread manure to cover crops that are well established prior to September 15. These crops can act as 'catch crops' to catch the nitrate in the root zone and reduce leaching. Rates of application on these lands should be lower than on grasslands due to the more immature root system.

Interior Regions. Because of frozen soils and low winter precipitation, winter losses of nitrate due to leaching are minimal. Therefore, a high percentage of any nitrate left in the root zone following harvest will be retained for subsequent crops. A fall or spring soil test will assist producers to take advantage of nitrogen from manure and reduce the need for fertilizer nitrogen.

NOVEMBER AND DECEMBER

South Coastal Region. With the onset of winter, soil cools to the point where there is very little formation of nitrate in the root zone. However, many soils are now too wet to allow ready access for spreading without causing severe soil compaction. If, however, the soil is sufficiently dry to support traffic, and flooding and runoff never occurs due to adequate on farm and regional drainage systems, some manure can safely be applied on grassland or land seeded to an overwintering cover crop. Manure should not be applied to bare land. No more than 40% of the annual allowable application should be spread between the September to December periods.

Interior Regions. See January, February and March.

9.4: Environmentally Sound Manure Management

The following must be taken into consideration if manure is to be managed in an environmentally sound manner.

LONG-TERM MANURE STORAGE

Maximum benefit is derived from manure when it is spread on the land in spring or summer. At this time leaching and runoff risks are low and crop growth and nutrient uptake is high. Adequate storage makes this possible by allowing more flexibility in choosing the correct time to apply the manure. *See Section 8, Manure Storage.*

ADEQUATE LAND BASE

To adhere to the recommended application rates, sufficient land must be available for the safe use of the amount of manure produced each year (see section 9.5, Manure Application Rates).

INCORPORATION OF MANURE

Incorporation either by injection, plough down, other tillage methods or irrigation should be practised to maximize nutrient recovery (by minimizing ammonia losses), reduce the likelihood of manure runoff and reduce odours.

PREVENT WATER CONTAMINATION

To prevent water contamination beef cattle manure should **not** be spread:

- within 5 m (17 ft) of a bank or a slope leading to any watercourse;
- within 30 m (100 ft) of streams flowing into shellfish growing areas or any well or spring used as a domestic water supply. These distances should be increased where the ground slopes toward the stream, watercourse or well;
- on steep slopes where erosion and/or surface runoff is likely to occur;
- on saturated soils, where manure will not infiltrate into the soil;
- within the high water mark of field depressions during times of the year when there is a high risk of direct surface runoff to a watercourse;
- in excess winds where drift can occur;
- on frozen or snow covered ground where runoff of snowmelt to open watercourses might occur; and
- on areas having standing water.

ODOUR CONTROL

Land applications of manure from intensive livestock production facilities frequently lead to complaints. Consideration of neighbours with respect to time of day and weather conditions when spreading manure can do much to avoid conflict. Longer storage periods to reduce the frequency of spreading, as well as immediate incorporation of the manure into the soil to minimize odour is encouraged.

The following spreading techniques should be considered to reduce odour nuisance problems.

- Apply manure early in the day when air is warming and rising and diluting odours, rather than later in the day when air is settling, cooling and concentrating odours.
- Try to spread on a cool day when odour production is lower.
- Try to spread all the manure in as short a time as possible.
- Whenever possible, avoid spreading manure on the weekends or holidays particularly on sites with neighbours near by.
- Use rapid cover techniques such as disking, ploughing down or soil injection.
- Spread on days when wind will not carry odours or manure particles into public places, roads or neighbouring lands.

9.5: Manure Application Rates

Management is the key to using manure to promote crop production and soil improvement

while minimizing any hazard to the environment. Management means application of manure at rates and times of year that:

- are compatible with the nutrient requirements and growing characteristics of the crop;
- take into account soil characteristics, drainage and the slope of the land; and
- recognize the need to protect the quality of surface and groundwaters.

The amount of beef cattle manure applied each year should be governed by the amount of nitrogen removed in the harvested portion of the crop. If the amount of nitrogen applied in manure exceeds crop needs, then, over time, nitrogen losses to the environment will be excessive. There are a number of factors that influence suggested application rates. Factors include: the amount of nitrogen in the soil, amount of manure added in previous years, the length of time manure is left on the soil surface before incorporation, amount of crop refuse left in the field, and presence or absence of a winter cover crop. For more detailed information see Appendix E, Beef Cattle Manure Land Application. Manure application rates are based on nitrogen. It is not a requirement to balance the other nutrients in manure to the crop utilization. This means that excess phosphorus will usually be applied to the soil. If the phosphorus does not runoff the soil, pollution is not likely to occur.

Manure Application Rates To Grassland. Well managed, productive grass swards that have a high requirement for nitrogen and extensive root systems are very efficient in taking nitrogen compounds from the soil profile. Therefore, leaching losses are generally low under productive grass swards. The low leaching losses of productive grass stands allows this crop to receive a higher manure nitrogen application rate per unit of nitrogen removed by the harvested portion of the crop compared to other crops.

Some fall and winter applications of manure can be considered if the following conditions are met:

- the land is not subject to flooding or runoff;
- the grass sward is managed for high yields and all vegetative growth is removed from the field during the growing season;
- the grass sward is not used for grazing; and
- application of manure does not harm the sward by causing smothering and scorching.

Land Area Suggested for Manure Spreading. Any operation spreading manure on less land than required should request a "Best Agricultural Waste Management Plan" (explained in Appendix A, BCMAFF Environmental Programs). To determine the amount of land required see the following formulas. Land areas required for manure fertilization are discussed for confined livestock areas, seasonal feeding areas and grazing areas.

CONFINED LIVESTOCK AREA MANURE

Cattle in confined livestock areas are contained on sites where no crop is grown or where a crop is grown but the amounts of manure nutrients exceed the crop requirement. Manure from cattle in confined livestock areas needs to be collected, stored if necessary, and then spread as a fertilizer onto cropland. Acceptable minimum area required to spread manure from beef cattle feeders, can be calculated using the following formula (see example 9.1).

$$\text{Hectares} = \frac{\text{Animal Days} \times \text{Spreading Area Coefficient}}{10{,}000 \times \text{Adjustment Factors}}$$

- Animal Days based on 455 kg (1000 lb) animal.
- The area can be adjusted by the manure application frequency: if manure is applied less than once every two years to a field the Adjustment Factor is 2.0.
- The area can be adjusted by the organic matter of the soil: for soil having 5 to 10% organic matter, the Adjustment Factor is 1.2, for soil having less than 5% organic matter

the Adjustment Factor is 1.4.

It is recommended that all the manure be applied in the spring before crop growth. This will result in optimum crop yields without any risk of nitrate leaching over the fall and winter period. If manure application is split between spring and fall, leaching hazards will increase. Fall and winter applications should be less than 40% of the total amount of manure applied during the year.

SEASONAL FEEDING AREA MANURE

Most cow calf operations confine the herd onto a relatively small land base in late fall, winter and early spring. The primary source of feed is conserved forage transported onto the feeding area. Manure is deposited directly onto the land by the cattle while feeding.

The distinction between a seasonal feeding area and a feedlot is that the amount of nitrogen from manure being deposited on the land in a seasonal feeding area does not exceed the needs of the crop to be grown in the following growing season. If manure nutrient application is more than crop needs, then the site is more properly characterized as a confined livestock area.

The following formula is used to size the minimal seasonal feeding area for overwintering a beef cattle cow herd so the manure that is deposited during the feeding period does not exceed the requirement of the crop grown (see example 9.2).

$$\text{Hectares} = \frac{\text{Animal days} \times \text{Feeding Area Coefficient}}{10{,}000 \times \text{Adjustment Factors}}$$

- Animal days based on a cow or a cow and calf.
- Feeding Area Coefficient shown in Table 9.3.
- The area can be adjusted by the manure application frequency: if manure is applied less than once every two years to a field the Adjustment Factor is 2.0.
- The area can be adjusted by the organic matter of the soil: for soil having 5 to 10% organic matter, the Adjustment Factor is 1.2; for soil having less than 5% organic matter the Adjustment Factor is 1.4.

Cattle overwintering areas require a high degree of management to minimize the risk of polluting surface water with contaminated runoff. See section 4.2, Seasonal Feeding Area Evaluation and 4.3, Runoff Control and Collection.

GRAZING AND RANGELAND AREA MANURE

Intensively Managed Pasture. Intensively managed pasture is becoming more prevalent as a management practice. Maximum productivity of such pastures is achieved through use of irrigation water and regular applications of nitrogen fertilizer. Since the forage is not mechanically harvested and conserved, some of the nitrogen in the forage is returned to the land in the form of manure. Research indicates that the potential for environmental contamination is greater from grazing systems than from systems where the forage is removed from the land. Therefore, it is important to ensure that the amount of supplemental fertilization corresponds to the amount of nitrogen removed in the meat of the animals plus the amount lost through volatilization.

Table 9.4 provides guidance on fertilization rates based on crop growth potential and time that the cattle are on pasture (see example 9.3). It is assumed that stocking rates are sufficient to harvest the entire amount of grass produced. If stocking rates are excessive and cause harm to the grass stand, then the site is more correctly characterized as a seasonal feeding area. If the pasture is only grazed part of the time and mechanically harvested the rest of the time Table 9.4 does not apply. Crop growth potential is an estimate of the amount of grass that could be harvested had the grass stand not been grazed.

Grazing on Rangeland. The stock rate of animals on rangeland is controlled by the carrying capacity of the range. This stocking rate is low (many hectares per animal). As a consequence, the risk of over application of manure causing pollution on rangeland is negligible when grazing.

9.6: Manure Spreading Equipment

Beef cattle manure spreading equipment should:

- be of tight construction so manure will not spill from it during transport (Figure 9.1);
- be operated in such a manner that the wheels do not carry manure onto public roadways; and
- be filled in such a manner that manure does not spill from the sides of the equipment creating unsanitary, messy conditions.

TABLE 9.1
TYPICAL NUTRIENT CONTENTS OF STORED BEEF CATTLE MANURE(a)

Management Type	Moisture Content percent(b)	Nitrogen		Phosphate	Potash
		Total kg/tonne	Total kg/tonne	Total kg/tonne	Total kg/tonne
Outdoor feedlot	67.8	4.2	0.2	4.8	8.2

To convert to Imperial units 1 kg/tonne = 2.0 lbs/ton

a. Data collected by North Okanagan Soil Conservation Group on North Okanagan beef cattle feedlots in 1991/92

b. If moisture content of manure is different then the value shown nutrient content per tonne will also change.

TABLE 9.2
SPREADING AREA COEFFICIENT FOR BEEF FEEDER CATTLE MANURE

	Hectares Per 10,000 Animals Days on Feed (455 kg animals)				
Type of Crop Receiving Manure	South Coastal	Kootenays	Okanagan Thompson	Central BC	Peace River
Cereals					
- Whole 2 cuts	---	---	4.2	---	---
- Whole 1 cut	22.0	9.4	6.9	13.2	12.0
- Grain only	10.0	---	13.8	---	55.0
Perennial Grass	3.9	6.3	4.3	13.5	---
Silage Corn	6.3	---	6.1	8.1	---
50% Grass, 50% Legume	---	10.0	7.0	9.5	19.0

To convert to Imperial units 1 hectare = 2.47 Ac
This table assumes the following:

- water for crop growth is not limiting (i.e., this table is not for dryland conditions)

- average crop yields and nitrogen removal of various crops are explained in Appendix E.

EXAMPLE 9.1
AREA CALCULATION FOR SPREADING BEEF FEEDER CATTLE MANURE

What is the minimum area of corn silage land in Kamloops required to spread the manure from a confined livestock area (feedlot) that feeds 250 cattle for five months with an average weight of 365 kg (800 lb.)?

The manure is spread annually on soil of 6% organic matter.

The number of Animal Days: = 250 cattle x 5 months x 30 days
= 37,500 Animal Days

$$\text{Animal Days based on 455 kg animal standard:} = \frac{37{,}500 \times 365 \text{ kg}}{455 \text{ kg}} = 30{,}082 \text{ animal days}$$

Spreading Area Coefficient from Table 9.2 for corn silage in Kamloops is 6.1 ha

Adjustment Factor for 6% soil organic matter is 1.2

$$\text{Hectares} = \frac{\text{Animal Days} \times \text{Spreading Area Coefficient}}{10{,}000 \times \text{Adjustment Factors}}$$

$$= \frac{30{,}082 \times 6.1 = 15.3 \text{ ha}}{10{,}000 \times 1.2}$$

Conversion to acres = 13.3 ha x 2.47 ac/ha
= 37.8 acres

This feedlot should spread the manure on a minimum of 15.3 ha (37.8 ac) of land that will be planted to corn silage.

TABLE 9.3
FEEDING AREA COEFFICIENT FOR AN OVERWINTERING SITE (SEASONAL FEEDING AREA)

	Hectares Per 10,000 Animals Days on Feed (cow, or cow and calf)				
Type of Crop on Seasonal Feeding Area	**South Coastal**	**Kootenays**	**Okanagan Thompson**	**Central BC**	**Peace River**
Cereals					
- Whole 2 cuts	---	---	3.3	---	---
- Whole 1 cut	17.0	7.3	5.4	10.2	9.3
- Grain only	7.7	---	10.6	---	42.5
Perennial Grass	3.0	4.9	3.3	10.4	---
Silage Corn	4.9	---	4.7	6.3	---
50% Grass, 50% Legume	---	7.7	5.4	7.3	14.7

To convert to Imperial units 1 hectare = 2.47 Ac

This table assumes the following:

- water for crop growth is not limiting (i.e., this table is not for dryland conditions)
- average crop yields and nitrogen removal of various crops are explained in Appendix E.

EXAMPLE 9.2
AREA CALCULATION FOR A BEEF OVERWINTERING SITE (SEASONAL FEEDING AREA)

What is the minimum area of a beef cattle overwintering site (seasonal feeding area) in Merritt for 250 cows for three months in a precalving area consisting of perennial grass which has 4% soil organic matter?

The number of Animal Days = 250 cows x 3 months x 30 days
= 22,500 Animal Days

Feeding area from Table 9.3 for perennial grass in Merritt is 3.3

Adjustment factor for 4% soil organic matter is 1.4

$$\text{Hectares} = \frac{\text{Animal days x Feeding Area}}{\text{10,000 x Adjustment Factors}}$$

$$= \frac{22{,}500 \times 3.3}{10{,}000 \times 1.4} = 5.3 \text{ ha}$$

Conversion to acres = 5.3 ha x 2.47 ac/ha
= 13.1 acres

This overwintering site needs to have a minimum of 5.3 ha (13.1 ac) of land in perennial grass.

TABLE 9.4
FERTILIZER NITROGEN GUIDE FOR INTENSIVELY MANAGED PASTURE(a)

Crop Growth Potential (t/ha dry matter)	Length of Time Cattle on Pasture (months)					
	1	2	3	4	5	6
	fertilizer nitrogen kg/ha					
4	9	17	26	35	43	52
6	13	26	39	52	65	78
8	17	35	52	69	87	104
10	22	43	65	87	108	130
12	26	52	78	104	130	156
14	30	61	91	121	152	182

To convert to Imperial unit 1 kg/ha = 0.9 lb/ac
1 t/ha = 0.45 tons/acre

(a) See Appendix E for description of assumptions used.

EXAMPLE 9.3
FERTILIZER NITROGEN CALCULATION FOR BEEF CATTLE ON INTENSIVELY MANAGED PASTURES.

How much inorganic fertilizer should be added to a pasture that has a crop growth potential of 12 tonne/ha (5.4 tons/ac) that cattle are intensively grazing for five months?

Suggested Maximum Nitrogen Fertilizer = Table 9.4 value
= 130 kg/ha Fertilizer Nitrogen

Conversion to lb/ac = 130 kg/ha x 0.9 $\frac{\text{lb ha}}{\text{ac kg}}$
= 117 lb/ac Fertilizer Nitrogen

In order not to have excessive losses of nitrogen for this field, no more then 130 kg/ha (117 lb/ac) fertilizer nitrogen should be added.

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Environmental Guidelines for Beef Producers

10: Composting of Manure

Utilization of manure as a fertilizer for crop production is generally recommended at this time. However, cases do exist where insufficient crop land is available to recycle all manure as a fertilizer. An alternative to direct land application of beef cattle manure is to compost the manure for off farm users.

In some cases, manure containing bedding (woodwaste or straw) is composted prior to land spreading. This helps to break down the bedding material.

Composting is a process that converts one form of organic matter into a more uniform and relatively odourless substance called humus or compost. The compost has considerable value as an organic soil conditioner and fertilizer.

Windrow composting involves the placement of the manure on an all-weather surface in long rows. Typically the rows are 1 to 2 m (3 to 6 ft) high, and 2 to 5 m (5 to 16 ft) at the base. The piles are turned periodically to mix and introduce air to the composting mixture. This helps to ensure that all the material is uniformly composted. Although mixing can be accomplished with regular farm equipment, the use of specialized equipment is usually more efficient. Windrow composting is relatively simple and inexpensive, but takes up to several months for completion. To hasten the process, complex high rate composting systems have been developed that can mechanically mix and aerate the composting materials. These systems are expensive, but could be practical on some larger beef cattle operations.

To ensure that pollution is not created at the composting site, ensure that:

- The site is located a minimum of 15 m (50 ft) from a watercourse, and 30 m (100 ft) from wells used for domestic purposes.
- Windrows are not located on coarse textured or gravelly soils.

- All clean surface water is diverted away from the composting site.
- All contaminated surface runoff from the composting area is contained to prevent flow into a surface watercourse. Contained runoff must be land spread according to the principles in Section 9, Land Application of Manure.
- Raw and composted material is stored in a suitable storage structure as outlined in Section 8, Manure Storage.
- In areas of high rainfall, a roof over the composting area may be required to keep the compost from becoming too wet. A roof reduces the amount of polluted runoff and leaching that must be stored.
- In areas of high rainfall, the storage of finished compost should be under a roof.

The value of the compost will vary and may require testing before spreading. Commercial composting facilities that receive manure or other wastes from more than one farm require a permit under the Waste Management Act. Note: At the time of writing it is proposed that all composting facilities (including agricultural types) will be required to register with BC Ministry of Environment, Lands and Parks.

For further information on composting, see the BCMAF **Agriculture Composting Handbook** listed in Appendix F, Reference Material.

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Environmental Guidelines for Beef Producers

11: Dead Animal Disposal

This section deals with the environmental concerns regarding the disposal of dead beef cattle. These deaths are those that occur during normal beef cattle operation, not during any meat processing or other similar operation.

11.1: Rendering

This preferred disposal method recognizes the secondary value of dead cattle. By rendering the carcass the disposal problem is removed from the beef cattle producer altogether. Some rendering plants may pick up the carcass for little or no fee. While waiting for pick up, move the carcass to a temporary holding site that is dry and not in a runoff or drainage area. If a pick up service is not available deliver the carcass to the plant as soon as possible.

11.2: Burial Pits

In many areas of the province a rendering service is not available. Beef cattle producers should then use another acceptable disposal method, complete burial. Properly sited and constructed burial pits will ensure the carcass will not attract predators and will not be a potential source of pollution. Burial pits should meet the following requirements:

- be located at least 120 m (400 ft) from wells or domestic water intakes;
- be located at least 30 m (100 ft) from any other surface water;
- be constructed so the bottom of the pit is 1.2 m (4 ft) above seasonal high water;
- be constructed to allow 1 m (3 ft) of earth cover;
- be sized for a maximum 700 kgs (1500 lbs) of animals; and
- be on sites that are staggered throughout the beef cattle

operation.

11.3: Fed to Predators

This is the least desirable disposal method and should not be used in most cases. There is a health concern if humans contact the carcass. It is also poor ranch practice to attract predators that might attempt to kill other livestock. Attracting predators especially at calving time can cause problems to yours, or your neighbour's operation. Any use of a carcass to bait predators for kill is illegal unless done under BC Ministry of Environment, Lands and Parks supervision.

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Environmental Guidelines for Beef Producers

12: Other Environmental Considerations

This section deals with a number of other environmental considerations. They include soil conservation, gases that cause global warming, woodwaste products, ranch horses, pesticides, chemigation, farm medical wastes, petroleum products, plastics and burning.

12.1: Soil Conservation

Any consideration of farming activities from an environmental perspective must consider soil conservation. Soil conservation includes any soil management practices that minimize soil loss from erosion, reduce degradation from acidification, salinization and compaction and increase the overall organic matter and fertility status of the soil.

Soil conservation practices are site dependant. They depend on soil and landscape conditions, type of farming operation and the critical factor of climate. In many instances it is the apparent disregard of the climate that is the major cause of soil degradation. Provisions must be made to protect the soil resources from degradation, particularly due to rain drop impact, and rainfall or snowmelt runoff.

Soil degradation from acidification, salinization, organic matter depletion and compaction has a great impact on soil productivity on the farm. Soil erosion will have obvious and significant impacts on the farm, but will have less apparent yet greater impacts off the farm. On-farm impacts range from loss of nutrients and organic matter to the complete loss of crops and land.

Soil eroded from farm fields that enters surface water can be considered a pollutant. Eroded soil is a pollutant if the concentration of either sediment or colloidal material affects fish and/or their habitat. These eroded soils can contain pesticides or nutrients that could be more harmful to the surface water ecosystem than the soil material itself. Eroded soil can lead to expensive and unnecessary

maintenance of roads and drainage systems.

Most soil degradation on beef cattle operations will likely occur as soil erosion or compaction. Erosion is primarily caused by snowmelt or heavy rainstorm events. Compaction can occur on cropland and grazing areas (either pasture or rangeland) due to tillage, harvesting equipment or livestock activity.

SOIL EROSION

To reduce the risk of soil loss due to runoff water in diversion ditches and in the feeding area, the following factors should be considered:

- **Soil texture.** Fine textured soils are more erodible. The greater the percentage of fine sand silt or clay in soil the greater the risk of erosion.
- **Topography.** Generally the greater the slope the more risk there is of erosion. Slopes greater than 5% are considered to have a moderately high risk of soil loss if left bare. Slope length is a factor, for example, when slope lengths are greater than 100 m (300 ft) the risk of soil erosion is higher.
- **Potential Water Volumes.** High intensity, short duration rainfall events in summer or snow melt runoff on frozen soil can result in severe erosion.
- **Surface Cover.** Generally the greater the amount of soil surface covered by vegetation, the less the risk of soil erosion. Permanent grass cover has a low risk, while temporary cover crops or straw mulch have a moderate risk and bare soil has the highest risk.

Most of the runoff that occurs around the seasonal feeding area will be the result of snowmelt on frozen ground. Runoff will also result from severe rainfall events. It is necessary to reduce the velocity of the flow and contain the flow in a structure or ditch. A properly designed ditch or grassed waterway will contain and control the flow. This water can be diverted to fields or watercourses if it remains uncontaminated. If the runoff is coming off the seasonal feeding area, the water should be contained as it will likely be contaminated with manure. Diverting runoff water to either containment lagoons (pits) or cropland is the proper method of handling contaminated water. Refer to Tables 4.1, 4.2 and 4.3 for information on runoff risk factors and to Figure 4.1 for an example of a seasonal feeding area layout.

More detailed information on soil conservation practices can be obtained from references such as the **Soil Management Handbooks** for either the **Lower Fraser Valley** or the **Okanagan and Similkameen Valleys**. These handbooks are listed in Appendix F,

Reference Material. Factsheets detailing the design and construction of grassed waterways, ditches and diversion structures are also available.

The following are some prevention and abatement measures to control soil erosion by water.

- Avoid tillage or excessive grazing activities that would leave soil bare, poor crop growth or poor crop residue cover late in the season on sloping lands.
- Use permanent pasture, rapid growing cover crops or water control structures to protect highly erodible sites.
- Use contour tillage and drainage systems to reduce runoff and saturated soil conditions.
- If soil is left exposed by an unforeseen soil management or crop production problem, attempts should be made to incorporate straw into the soil surface. Any tillage to incorporate straw should be on the contour. Efforts should be made to divert any runoff containing soil to a settling pond prior to discharge.

12.2: Gas Emissions that Cause Global Warming

Certain gases in our environment act like a greenhouse, trapping the sun's heat, which then heats our atmosphere and causes global warming. This process is known as the greenhouse effect. Carbon dioxide and other principle gases that contribute to the greenhouse effect are increasing in concentration due to discharges caused by human activities.

The federal government has committed Canada to stabilizing gas emissions that cause the greenhouse effect at 1990 levels by the year 2000. Agriculture helps by absorbing greenhouse gases such as carbon dioxide. Agriculture does contribute to the greenhouse gas accumulation by the production of methane, nitrogen oxide and carbon dioxide. Improved treatment, handling and utilization of manure offers the greatest potential for the reduction of methane and nitrogen oxide gases. Agriculture must be aware of the need to reduce greenhouse gas emissions and be willing to do its part.

The provincial government's clean air strategy may involve initiatives for agriculture that are not addressed in these guidelines. At present it is not clear the affect agriculture has on the greenhouse effect. Research on agriculture's emission sources and potential activities for remediation will help to identify agriculture's role.

12.3: Woodwaste Products

Woodwaste products play an important role in the rearing of beef cattle. The majority of beef cattle operations that require bedding use a woodwaste product, such as, sawdust or shavings. This woodwaste breaks down with the manure to form a soil amendment when applied to cropland.

Woodwastes, when improperly handled can become a threat to the environment. Leachate from stored woodwaste entering surface or groundwater causes pollution. Leachate is formed when exposed woodwaste has contact with, rainwater or surface water. Leachate is identified as the black liquid forming at the base of the woodwaste pile. This black liquid is deadly to fish and degrades water quality.

Some considerations for the use and handling of woodwaste are:

- Woodwaste on farms may only be used for: plant mulch, soil conditioning, animal-poultry bedding, ground cover, equestrian facilities, on farm access ways and berms used in cranberry production.
- Sites where woodwastes are used must be located at least 30 m (100 ft) from any source of water used for domestic purposes.
- Woodwaste can not be used for a landfill material without a permit or approval from the BC Ministry of Environment, Lands and Parks.
- Woodwaste products stored on the farm must be stored in such a manner that leachate does not escape to surface or groundwater. Covering stored woodwaste is an effective means of reducing leachate production.
- Woodwaste bedding when removed from the barn must be stored in compliance with Section 8, Manure Storage in these guidelines. Correct storage will not allow leachate to enter surface or groundwater.
- Repeated application of manure, heavily bedded with woodwaste products onto cropland, may result in shift of the C:N ratio. Changing the C:N ratio could reduce the ability of crops to grow.
- For more information, consult the **Woodwaste Guidelines** listed in the reference section (Appendix F).

Woodwaste may contain chemicals used for the preservation of wood, for stain prevention or for fire retardation. Chemicals such as penta and tetrachlorophenol can be found in cattle as a result of breathing in, eating or touching chemicals in treated wood. Care must be taken by the beef cattle operator when chemically, treated woodwaste is used

on the farm.

12.4: Ranch Horses

Horses used on a beef cattle operation, like cattle, may be kept on grazing, seasonal feeding or confined livestock areas. Horses require water, feed, housing and handling structures. All the beef cattle environmental concerns addressed in this guideline also apply to horses. The number of horses on a beef cattle operation is usually small. However, horses may be of concern if held in confined livestock areas.

Grazing Areas. Horses on rangeland or pasture should be grazed considering the points discussed in Section 4.1, Grazing Areas. There should be few environmental concerns with proper water access and good management.

Seasonal Feeding Areas. Horses held on these areas will require a pollution risk evaluation similar to cattle. Refer to Section 4.2, Seasonal Feeding Areas.

Confined Livestock Areas. Ranch horses are sometimes held on sites such as exercise yards or corrals. These sites are defined as confined livestock areas. As with cattle, horses on these areas cannot have direct access to natural water sources, but must be watered using livestock waterers. Cleaning and spreading of manure and runoff control must be considered as discussed for cattle in Section 4.3, Confined Livestock Areas.

On small farms of less than 10 agricultural units, livestock can be held in confined livestock areas that are within the recommended 30 m (100 ft) setback from a watercourse. However, as the 10 agricultural units include all farm livestock on the farm, it is unlikely this provision will apply to beef cattle operations.

12.5: Handling and Disposal of Pesticides

This section outlines good agricultural environmental practices to be followed when using pesticides. As there are numerous articles readily available outlining personal protection when using pesticides, the aim here is to identify steps directed at protecting the environment. A pesticide applicator course for agricultural producers is available from the BC Ministry of Environment, Lands and Parks. There are a number of restricted pesticides that can only be applied by an applicator who has passed an applicator's course and has been certified.

Agricultural production guides with reference sections on pesticide use are available from the BC Ministry of Agriculture and Food. For more general information on pesticide application see **The Handbook for Pesticide Applicators and Dispensers** listed in Appendix F, Reference Material.

TRANSPORTATION

The following items should be considered when transporting pesticides:

- only transport undamaged, and labelled pesticide containers that are securely closed;
- secure pesticides during transport;
- transport pesticides on non-absorbent material (e.g., metal or plastic, not wood);
- the total quantity of pesticide product in the vehicle cannot exceed 500 kg (1,100 lbs); and
- sprayers containing a spray mixture in excess of 5,000 litres (1,320 U.S. gal) cannot be driven on a public road.

SAFE USE OF PESTICIDES

Before mixing pesticides:

- identify the pest correctly;
- use only recommended pesticides for the problem;
- read the label and follow the safety precautions;
- ensure application equipment is in good working order and properly calibrated; and
- be prepared to handle a spill, (see in this Section, Pesticide Spills on the Farm for details).

While mixing and applying pesticides:

- observe a 10 m (35 ft) pesticide free zone from all watercourses;
- mix only the pesticide you need for that day;
- always have water available for washing;
- do not exceed the rate specified on the label; and
- have an approved backflow prevention device on the waterline used to fill the sprayers.

DRIFT CONTROL

Drift refers to the movement of pesticide droplets or dust, by wind or air currents, away from the target area. Drifts may be in liquid-droplet or vapour form. Liquid-droplet drift is related to droplet size.

The smaller the droplets, the further the wind can carry them from the target. Droplet size or the distance from the nozzle to the target influences the amount of liquid-droplet drift.

Vapour drift from volatile chemicals can continue long after the spraying operation. Small amounts of highly volatile pesticides can injure susceptible plants, as well as impact a watercourse well outside the treated area. This injury often occurs during stable air conditions, which allow the vapours to collect and remain undiluted.

To minimize spray drift, take the following precautions:

- use low spraying pressure to reduce the number of fine spray droplets produced;
- keep boom height as low as possible while maintaining uniform coverage;
- use nozzles that produce drops more resistant to drift, such as low-pressure, flat-fans, flooding or raindrop;
- choose chemicals that do not require high pressure and fine droplets;
- replace or clean faulty nozzles that cause fogging;
- use low volatility chemicals that reduce vapour drift;
- use antidrift additives to increase viscosity at the nozzle orifice so that fewer fine droplets are produced;
- use special, low volume type sprayers; and
- spray when winds are less than 8 km per hr (5 miles per hr). Early morning and evening are often good times, particularly for very volatile chemicals.

DISPOSAL OF PESTICIDE CONTAINERS

Empty pesticide containers can be hazardous to the environment if not disposed of properly. Producers should take the following precautions:

- drain the container into the tank;
- rinse the container three times, pouring the rinse water into the sprayer tank each time;
- crush or puncture the container so that it cannot be reused;
- deliver the container to a sanitary landfill or store in a safe place for a short time until delivery can be made; and

- clean sprayers or empty containers as far from a watercourse, ditch, or well as required to eliminate the possibility of pesticides being washed back into the surface or ground water.

PESTICIDE STORAGE

Pesticides should be stored in a dry, well ventilated building that can be locked. The storage must be located away from watercourses and from wells to avoid contamination in the event of a spill or a fire. It is a good idea when storing liquid pesticides to provide a sump made of concrete or other impervious material that will contain a spill and subsequent washing.

Further considerations are as follows:

- separate the storage facility from working and living areas;
- follow label directions for storage;
- place a warning sign on entrances;
- tightly close containers;
- do not store pesticides with food, feed, fertilizer or seed;
- use the storage facility for any pesticides that are not currently in use;
- do not store personal protective equipment in the storage facility. Keep it nearby in case of an accident;
- store herbicides away from other pesticides;
- keep absorbent materials like clay, kitty litter, sawdust, etc., handy in case of a spill; and
- keep an updated list of stored pesticides and inform the local fire department of the contents and location of the pesticide storage facility.

DISPOSAL OF UNWANTED PESTICIDES

Disposal of unwanted pesticides is a critical problem and has no simple solution. The best precaution against pesticide disposal is good planning.

Only purchase quantities of pesticides that you should be able to use up within two years. Prepare the exact amount of spray mixture that you need.

Accurate knowledge of field size and sprayer output will help avoid mixing excess spray material. If youend up with surplus mixture, avoid reapplying it to your crop as it may result in high pesticide residue levels. Instead, you could spray the headlands but be aware that high herbicide residues could affect future crops. Do not apply

pesticides next to ditches, watercourses or wells. When there is a need to dispose of excess spray mixture, use a carefully selected waste area. The waste area should be away from people, crops, watercourses, sewers and ditches and should not be on land subject to flooding. The soil at the waste area should be fine (e.g., clay) rather than coarse (e.g., sand) to prevent leaching into groundwater. Do not dump spray mixtures where you may dig a well, put up a building, or plant a crop in the future.

Sometimes you may no longer need certain pesticides. Unwanted pesticides should be disposed of properly, not stored. If you have unwanted pesticides and need information, advice or assistance regarding disposal, contact the nearest office of BC Ministry of Environment, Lands and Parks.

PESTICIDE SPILLS ON THE FARM

Occasionally pesticide spills occur. If this happens immediately contact the BC Ministry of Environment, Lands and Parks and Medical Health Officer and explain the circumstances surrounding the spill. The following are a few guidelines for cleaning and decontaminating the area:

- Prevent people and animals from being exposed to the pesticide and its fumes.
- For your own safety, tell someone that you are cleaning up a pesticide spill, where you will be and when you are expected to return.
- Put on protective equipment before cleaning up the spill. Rubber boots and gloves are necessary. Overalls, a respirator and eye protection should be worn for toxic and very toxic pesticides. Remember you are handling concentrated pesticides.
- Prevent the spread of the pesticide. Cover a liquid pesticide with soil, sawdust or any absorptive material.
- Ventilate the area.
- Once the liquid is absorbed into the material, remove the contaminated material to a safe place. Bury the contaminated material at least 50 cm (20 in) deep in an area that will not be cropped and is a minimum of 30 m (100 ft) from a watercourse. Also, avoid areas that can leach to groundwater or are subject to flooding.
- Decontaminate the surface. Check the label for specific directions. Many pesticides can be detoxified by washing the area with chlorine bleach and detergent. Take care to prevent the wash solution from spreading and contaminating a larger

area.

If the spill occurs outside on the ground, cover with soil and allow the pesticide to soak into the ground. DO NOT use this as a method of disposing of excess amounts of pesticides. If the spill occurs beside a watercourse, remove the top layer of contaminated soil and bury it as described in this section called Disposal of Unwanted Pesticides.

Contamination caused by chemical spills that occur during sprayer filling are a major concern. It is recommended that a plan be in place to prevent this occurrence. A plan should provide for:

- a berm around the well that will deflect surface spills away;
- a sprayer filling location sited at a lower elevation than the well;
- a location for sprayer filling sited 10 m (35 ft) away from well; and
- standby equipment including absorptive material, shovel, etc., that is readily available.

12.6: Chemigation

Chemigation is the practice of injecting chemicals into an irrigation system for application to a crop or field. Chemicals that are injected include fertilizers, herbicides, insecticides, fungicides, nematocides and possible growth regulators. The practice of chemigation is rapidly expanding due to the many advantages that are offered to producers. In some instances there is a potential for reducing the amount of chemical applied.

Chemigation does, however, present a risk. Potential contamination of the water source due to backsiphonage and backpressure is possible if an unexpected shutdown of the irrigation system shouldoccur while injection is taking place. This risk can be minimized if proper backflow prevention devices are installed and proper chemigation procedures are followed.

A BCMAF publication **Chemigation Guidelines for B.C.** is available. This publication is listed in Appendix F, Reference Material. The intent of this publication is to inform producers of the laws, regulations and standards that currently exist in British Columbia. The publication provides information on irrigation system design and operation of chemigation systems, guidance on the selection of chemicals for injection and outlines methods of calculating chemical injection rates.

Current laws and regulations are in place for some water suppliers.

Unfortunately, backflow prevention standards differ between districts and municipalities. Producers obtaining water from streams or other natural sources are not under the authority of a water supplier. In these instances standards are not usually enforced. The chemigation manual should be used by agricultural producers as a chemigation standard in instances where a higher authority has not established a standard.

The most common use of chemigation by beef cattle producers is likely to be application of forage crop fertilizers. The term fertigation is used to describe this particular form of chemigation.

12.7: Farm Medical Wastes

The use of medication in livestock production is a common practice. There is a growing volume of spent medicines, empty containers and other medical items that must be disposed of in an acceptable manner.

For most beef cattle producers incineration of farm medical waste in an **approved** facility (an incinerator designed to consume medical waste) is not possible. Those producers should consider the following:

- farm medical waste that has the potential to puncture or cut be packaged in a rigid container (plastic) and discarded with household waste;
- disinfect needles, syringes and other items prior to discarding by boiling for five minutes or soaking in disinfectant;
- needles be 'ground-off' or otherwise destroyed to eliminate the chance of puncturing a trash handler;
- medical supplies that have outlived their shelf life be taken back to the suppliers; and
- the BC Ministry of Environment, Lands and Parks be contacted if quantities destined for disposal are in excess of 5 kg (10 lb) or 5 litres (1 gal).

12.8: Petroleum Products

On farm receiving and dispensing sites for gasoline and diesel fuels are potential sources of pollution. Fuel spills and disposal of used oils can be a major threat to soil and water quality. It takes very little product to have a detrimental effect on the receiving environment.

When handling, storing or disposing of petroleum products consider the following:

- fuel tanks must be equipped with an anti-siphoning device included in the tank discharge unless a self-closing nozzle is provided;

- drains must be lockable in the closed position;
- storage tanks must be constructed in accordance with accepted engineering practice, and may include a concrete, dyked facility;
- tanks must be located away from yard drains;
- tanks should be set back 10 m (35 ft) from a watercourse or ditch;
- care must be taken when filling the tank to ensure no overflow occurs;
- care must be taken when dispensing fuels to ensure no overflow occurs; and
- the tank should be protected from direct collision by farm vehicles.

For disposal of spent or used oils, the best alternative is to return the oil to an approved recycling centre for recycling. Used oil when applied to roads as a dust suppressant is a threat to the environment and receiving waters.

12.9: Plastics

Plastics are used in many areas on beef cattle operations. A considerable amount of plastic is used in feed storage, such as covering hay or in bagging chopped and round baled silage. It is also commonly used for hay twine, buckets, etc. Farm plastics should be disposed of, reused or recycled. Only plastics that have contacted or contained toxic materials, such as pesticides need to be disposed of as outlined in Section 12.5, Disposal of Pesticides Containers.

The best method of handling plastics is by recycling. Some distributors of plastics are currently considering recycling systems to reduce the environmental concerns of their clients. Until recycling is available, plastic sheeting, bags, twine and other farm plastics should be cleaned up and disposed of at an approved municipal land fill site.

12.10: Burning

Material being burnt should be restricted to straw, hay, untreated wood and brush. Plastics, tires and garbage should not be burned. Producers should consult Environment Canada's Ventilation Index before burning to verify atmospheric conditions are suitable for adequate dispersal of smoke and particulate. The Ventilation Index is available from the regional offices of the BC Ministry of Environment, Lands and Parks, Environmental Protection staff.

The BC Ministry of Environment, Lands and Parks does not require a permit for burning of crops or stubble; or burning for land clearing or tillage reasons if:

- the volume of material to be burned does not exceed 10 m3/ha per month (140 ft3/ac per month); and
- the duration of the burn is less then 24 hours.

The BC Ministry of Forests requires a burning permit for land clearing, machine piles, logging debris and broadcast burning. Producers should contact both Ministries before conducting any burning.

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Environmental Guidelines for Beef Producers

A: BCMAF Environmental Programs

The British Columbia Ministry of Agriculture and Food (BCMAF) has four non regulatory environmental programs. The four programs outlined below are: Best Agricultural Waste Management Plans, Best Soil Management Plans, Nitrogen Behaviour Simulation Model, and ALDA.

A.1: Best Agricultural Waste Management Plans

Best Agricultural Waste Management Plans provide waste management suggestions to beef cattle producers who have pollution concerns caused by:

- livestock manure (collection, storage or spreading);
- dead animals (disposal);
- livestock feed; or
- yard runoff (clean water running into livestock yards, or manure running out of yards).

Best Agricultural Waste Management Plans are not intended to address pesticide pollution concerns.

Producers who want a Best Agricultural Waste Management Plan prepared for their farm should contact their local agricultural. The District Agriculturist will discuss the need for the Plan with you. The request for a Plan is then sent to the Soils and Engineering Branch. An engineering specialist will visit the farm with the producer. Jointly they will develop the Best Agricultural Waste Management Plan to address the pollution concerns.

The Plan will consist of a written description of the present situation, possible pollution problems, suggestions for improvement, and sketches if appropriate. The suggestions are grouped into three areas: (A) very important, (B) important, and (C) should be considered. The

plan will also indicate works that require a professional engineer design.

When all the concerns in the Best Agricultural Waste Management Plan are addressed, the beef cattle producer's operation should be in compliance with all provincial and federal environmental laws and regulations.

A.2: Best Soil Management Plans

Best Soil Management Plans are intended to provide soil management recommendations for farms that have problems with:

- soil erosion;
- soil compaction;
- organic soil subsidence;
- soil structure deterioration;
- soil moisture deficit (where irrigation is not available);or
- soil acidity.

Best Soil Management Plans are not intended to address routine soil management concerns, such as soil fertility.

Soil management recommendations identified in the Best Soil Management Plans may require professional expertise to implement.

Those producers wishing to take part in the program should follow the same procedures used to obtain a Best Agricultural Waste Management Plan.

A.3: Nitrogen Behaviour Simulation Computer Model

The model simulates nitrogen behaviour from the time that it leaves the animal as manure until it enters the soil and is eventually taken up by a crop, lost to the environment, or becomes a component of parts: soil organic matter. The model consists of four manure transformations during collection, storage and spreading; soil processes; crop growth; and water movement through the soil.

Four categories of input information are required from the user: manure type and characteristics, soil type, climatic parameters and crop type. This information is used by the model to predict the crop yield, crop nitrogen uptake, organic nitrogen mineralization, and nitrogen losses due to volatilization, leaching and denitrification.

The model can be used to assess manure management practices to

determine effect on crop production. The model also will predict the potential for environmental contamination.

Producers wishing to assess their situation using this model should contact the Soils and Engineering Branch (address on back cover).

A.4: The ALDA Program

The ALDA Program (Agricultural Land Development Assistance Program) provides low interest loans for onfarm capital improvements. Agricultural credit is available for a minimum project cost of $5,000. The maximum loan per farm operation is $75,000. Loans are for a 15 year term and interest rates are at half of the bank prime rate on approved credit.

Application to the ALDA Program is made by contacting the District Agriculturist or District Horticulturist at your local BCMAF office (see list inside back cover).

A sustainable agriculture industry depends on the effective use of farming practices that maintain and enhance soil and water quality. However, those practices must be costeffective. Often, implementing sustainable farming practices are expensive, in these cases the ALDA Program is there to help.

There are many items that qualify for ALDA assistance. For example, manure storage facilities qualify. The ALDA program has been expanded to include loans for environmental initiatives. Under the Environmental Initiatives Section, a producer can obtain financial assistance for the capital items that have been identified as qualifying in a Best Agricultural Waste Management Plan or Best Soil Management Plan. Part of the capital costs of these items includes the costs of a professional engineer or agrologist where used.

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Environmental Guidelines for Beef Producers

B: BC Federation of Agriculture

B.1: Agricultural Environmental Protection Council

Farm leadership is essential in dealing with soil, water and air environmental concerns. The adoption of environmentally sustainable production practices is an aim of the BC Federation of Agriculture. Research scientists, farm advisors, agribusiness environmental experts and others are required to provide farmers with information, guidance and assistance. However, the change to environmentally sustainable agriculture can only be implemented by individual farmers on their own farms. In 1990, the BC Federation of Agriculture formed the Agricultural Environmental Protection Council. The purpose of the Council is to resolve nuisance and pollution complaints against farms and ranches in BC. This is done by peer producers explaining the concerns and helping to find a solution to an individual producer's environmental problem. Education is the preferred first step before regulatory agencies force farmers to adopt corrective measures.

The Agricultural Environmental Protection Council (AEPC) has grown out of the Agricultural Environmental Service (AES) Program. The AES had its beginnings as the Poultry Sanitation Committee that was formed in the 1960s. The AES program grew to handle complaints regarding nuisance of improper waste handling on beef, dairy, hog and poultry farms. Where the AES primarily handled nuisance complaints from the public, the AEPC will respond to both pollution and nuisance concerns. Concerns can come from both the public and government agencies. All member commodity groups of the BC Federation of Agriculture are invited to take part in the program. Therefore, the AEPC will cover a broader cross section of agriculture.

The aim of the AEPC is to set and maintain high environmental standards for participating commodities. To do this the AEPC has developed and is monitoring a program that responds and resolves nuisance and pollution complaints against farms and ranches in BC.

The Agricultural Environmental Protection Council has representation from: the BC Federation of Agriculture, participating agricultural commodity groups; BC Ministry of Environment, Lands and Parks; and BC Ministry of Agriculture and Food. Agricultural commodity groups volunteer to participate in the AEPC and its peer inspection program.

Upon receipt of a complaint, the AEPC will initiate the following process:

1) To contact the local peer inspector/advisor and have the complaint

investigated within two weeks of receipt of the complaint.

2) The local peer inspector/advisor will write an inspection report explaining what the environmental concern is and if it is justified. The report will also explain what corrective measures are required, and a date by which the corrective measures should be installed and operating. This inspection report is sent within two weeks of the inspection to the farm complained against, as well as the person complaining and to the AEPC.

3) To contact local peer inspector/advisor to do a follow up visit to the farm complained against. This follow up visit to occur on or about the date that the corrective measures should have been installed. Normally, this would be not more than six months after receiving the complaint.

4) The local peer inspector/advisor will write a compliance report explaining if the corrective measures were all installed as outlined in the inspection report (see 2 above). If all the corrective measures are not installed the inspectors should try to find out why. This compliance report is sent within two weeks of the follow up visit to the farm complained against, the person complaining and to the AEPC.

5) Farmers who are still causing an environmental problem after going through steps 1 to 4 will be referred to the appropriate government agency.

Farms that are farming in an environmentally sound manner or those that, after inspection, change to an environmentally acceptable method should not have to deal with the regulatory agencies. Only those farmers who choose to remain farming in an environmentally unacceptable manner will be under the influence of the regulatory agencies.

This process also allows the AEPC to review all inspection and compliance reports. AEPC can make sure all farms are treated fairly, and that inspector/advisors are making reasonable suggestions.

As there is a need to respond to complaints promptly there are inspectors/advisors for each commodity throughout the province.

Inspector/advisors in each of the commodities receive training. Making them aware of the requirements and standards set out by the AEPC. Training includes methods of reporting, how to get technical assistance to the farm, and when to involve a regulatory agency.

The Environmental Guidelines for Beef Cattle Producers in British Columbia is the standard used by the beef cattle peer inspector/advisors to determine compliance with the Code of Agricultural Practice for Waste Management.

The AEPC will review this process on a regular basis to ensure that high agricultural waste

management standards and environmentally responsible agricultural waste management practices are maintained on British Columbia's farms and ranches.

B.2: AEPC Relationship to Regulatory Agencies

The Agricultural Environmental Protection Council will, in most cases, be the

initial mechanism for resolving agricultural environmental complaints. See Table B.1 (in this Appendix) for ways that the complaint could travel to the AEPC Program.

There is nothing written to suggest that the AEPC must receive the first opportunity to solve the complaint. Providing AEPC can make sound resolutions and recommendations that result in addressing the complaint fully on the first inspection, the first opportunity to resolve the complaint should be with the AEPC. It must be pointed out that the BC Ministry of Environment, Lands and Parks has the right to take action at any time pollution occurs, or if producers do not meet the Code of Agricultural Practice for Waste Management. Beef cattle producers are well advised to clean up existing waste problems before they become an issue.

Table B.1 summarizes how the various agencies that are involved interrelate when addressing environmental concerns. Table B.1 also contains a column showing the agency that will become involved when there is non-compliance with AEPC recommendations or if the recommendations do not solve the complaint.

The legislative authority for enforcing provincial environmental standards is the BC Ministry of Environment, Lands and Parks under the Waste Management Act, the Agricultural Waste Control Regulation and the Code of Agricultural Practice for Waste Management.

TABLE B.1
GUIDELINE TO THE INTERRELATIONSHIP OF THE FEDERATION AEPC PROGRAM AND GOVERNMENT AGENCIES

Type of Environmental Concerns	Severity of Issue	Who to Contact	Inspection & Recommendations	Re-Inspection for Compliance	For Non-Compliance Final Action
Pollution of Air or Water	Severe	MOE	MOE/AEPC	MOE	MOE
	Non-Severe	MOE	AEPC	AEPC	MOE
Pollution of Fish Habitat: Provincial	Severe	MOE	MOE/AEPC	MOE	MOE
	Non-Severe	MOE	AEPC	AEPC	MOE
Pollution of Fish Habitat: Federal	Severe	DFO	DFO/AEPC	DFO	DFO
	Non-Severe	DFO	AEPC	AEPC	DFO
Human/Public Health Severe Implications	Severe	MOH	MOH/AEPC	MOH	MOH
	Non-Severe	MOH	AEPC	AEPC	MOH
Nuisance		AEPC	AEPC	AEPC	Local Government
Environmental Audit		MAF	MAF/BAWMP Consultant		

LEGEND:

AEPC	Agricultural Environmental Protection Council (BC Federation of Agriculture)

BAWMP	Best Agricultural Waste Management Plan (BCMAF)
DFO	Department of Fisheries and Oceans
MAF	BC Ministry of Agriculture and Food
MOE	BC Ministry of Environment, Lands and Parks
MOH	BC Ministry of Health

NOTE: An Environmental concern may be of interest to more than one agency.

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Environmental Guidelines for Beef Producers

C: Agricultural Waste Control Regulation and Code of Agricultural Practice for Waste Management

The Code of Agricultural Practice for Waste Management was drafted by the Ministry of Environment, Land and Parks; Ministry of Agriculture and Food; Ministry of Health; Federation of Agriculture; the Federal Department of Fisheries and Oceans; and with local government representation.

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Environmental Guidelines for Beef Producers

D: Confined Livestock Runoff Calculations

The size of detention basins to store runoff from confined livestock areas depends on the size of the runoff area and the amount of runoff that occurs while storage is required. Under most British Columbia conditions, this critical period is the winter six months. Storing runoff for this period will avoid application of the runoff on snow or frozen ground. Formulas can be used to obtain a design value for the amount of runoff. A local hydrologist can use these formulas, taking into account the conditions familiar to him. To obtain a first approximation for design, use the following formulas as a guide:

For paved feedlot

$$V = A \times (0.48\ P_m + 0.65\ P_s)$$

For unpaved feedlots

$$V = A \times (0.22\ P_m + 0.45\ P_s)$$

For solid manure storages

$$V = A \times (0.25\ P_m + 0.65\ P_s)$$

where (in any consistent units),

V = volume of storage

A = area contributing to runoff

P_m = sums of the November to April (6 months) mean monthly total precipitation (rainfall plus equivalent water depth of snowfall)

P_s = the 24-hour precipitation from a storm expected once in 25 years.

These formulas suggest that the design storage capacity be based on the detention of winter runoff plus the storm runoff that may occur before emptying the storage in the spring. At that time, and at times following major runoff events between May and October, the runoff can be applied to crop land for utilization of the fertilizer nutrients.

Precipitation data for most locations in BC is available in "Canadian Climate Normals" from Environment Canada or from the local BC Ministry of Agriculture and Food offices.

Table 4.4, page 20, was developed using the unpaved feedlot formulas and a collection area of 1000 m2.

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Environmental Guidelines for Beef Producers

E: Beef Cattle Manure Land Application

E.1: Detailed Calculations

Acceptable minimum area required for manure spreading can be calculated using the following formula:

$$\text{Hectares} = \frac{\text{Animal Days Feed} \times \text{Manure N Factor}}{\text{Crop N Removal} \times \text{Adjust. Factor} \times \text{Crop Yield}}$$

- **Animal Days:** Based on
  -- feedlot cattle weighing 455 kg (1000 lb)
  -- overwintered cow or cow and calf
- **Manure N Factor:** (see assumption E.2)
  -- 0.11 kg N per animal day for feedlot cattle
  -- 0.085 kg N per animal day for overwintered cattle
- **Crop N Removal:** Are found in Table E.1
- **Adjust. Factors:** Are found in Table E.2
- **Crop Yield:** Should be the normal yield per hectare (see Table E.3 Typical Crop Yields)

TABLE E.1
NITROGEN REMOVAL PER HARVESTED TONNE OF VARIOUS CROPS

Crop	Protein Levels	kg N Removal per Tonne of Crop Removed
Cereals - grain only	12.5	20.0
Cereals - whole crop	10.0	16.7
Grass	12.0	23.3(a) (per tonne dry matter)
50% Grass - 50% Legume	12.0	11.6(a) (per tonne dry matter)
Silage Corn	8.0	12.9 (per tonne dry matter)
Broccoli		10.0
Brussels Sprouts		10.0
Cabbage		3.7

Carrots		3.0
Cauliflower		6.3
Lettuce		2.5
Onions		2.7
Potatoes		4.6
Raspberries		7.7
Sweet Corn		8.0

To convert to Imperial unit: 1 kg N/tonne = 2.0 lb/ton

(a) N removal has been increased by 25% to account for increased volatilization losses of nitrogen.

TABLE E.2
ADJUSTMENT FACTORS TO BE USED WITH TABLE E.1

1. Soil organic matter	less that 5%	1.4
	5 to 10%	1.2
	more than 10%	1.0
2. Application frequency	frequent	1.0
	one time or infrequent	2.0
	(less than once every two years)	
3. Protein levels in forage crops	Ratio of actual levels to levels in TABLE E.1 example: if grass protein actually is 16%	16 / 12 = 1.3

E.2: Assumptions

CONFINED LIVESTOCK AREAS

Nitrogen in Manure: Beef cattle in a backgrounding or finishing operation excrete 0.18 kg (0.39 lb) of nitrogen per day per 455 kg (1,000 lb) live weight. Nitrogen lost to the atmosphere during collection and storage is 36%. The amount of nitrogen remaining for spreading is 0.11 kg (0.25 lb) per day per 454 kg (1,000 lb) live weight beef feeder.

Losses during and following spreading: Most of the ammonia in the manure is lost during storage. Losses during and following spreading will be minimal if incorporation occurs a day or two following application. On grassland where incorporation is not possible, nitrogen losses are assumed to be 25% greater than on arable land.

Table 9.1 was developed using average crop yields and protein levels shown in Table E.1.

SEASONAL FEEDING AREA

Nitrogen in Manure: Each cow excretes 0.14 kg (0.31 lb) of nitrogen per day. Manure deposited on the land loses 40% of the nitrogen to the atmosphere by volatilization. The amount of nitrogen remaining after volatilization losses is 0.085 kg (0.19 lb).

IRRIGATED PASTURE AND CONTROLLED GRAZING

Nitrogen in Manure: The animal excreted in urine and feces, 70% of the nitrogen it ingested. Manure deposited on the ground loses 50% of the nitrogen to the atmosphere by volatilization.

Nitrogen in Forage: The grass contains 2% nitrogen at time of ingestion.

TABLE E.3
TYPICAL CROP YIELD AND PROTEIN LEVELS(a)

Crop	South Coastal		Kootenays		Okanagan Thompson		Central BC		Peace River(b)	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	t/ha	%	t/ha	%	t/ha	%	t/ha	%	t/ha	%
Cereals - Grain only(c)	4-7	10-14	--	--	2-6	11-16	--	--	1	10-14
Cereals - whole crop 1 cut(c)	2-4(d) 12-15	5-9	8-11	6-13	10-12	3-7	7-12	2-9	7-10	
Cereals - whole crop 2 cut(c)	--	--	--	--	13-18	6-12	--	--	--	--
Grass(c)	11-13	15-18	4-11	8-18	9-13	8-19	2-5	8-12	--	--
50% Grass - 50% Legume(c)	--	--	6-13	8-18	9-18	8-16	8-12	8-16	2-8	8-16
Silage Corn(c) 11-16	8	--	--	12-16	7-8	8-13	7-8	--	--	
Broccoli	9-13		---		---		---		---	
Brussels Sprouts	9-13	---	---		---		---		---	
Cabbage	18-31	---	---		---		---		---	
Carrots	34-56	---	---		40	---	---		---	
Cauliflower	11-18	---	---		---		---		---	
Lettuce	34-45	---	---		---		---		---	
Onions	34-56	---	---		---		---		---	
Potatoes	15-45	---	22-45	---	22-45	---	---		---	
Raspberries	7-13	---	---		2-9	---	---		---	
Sweet Corn	13-20	---	---		10	---	---		---	

To convert to Imperial Units 1 tonnes/hectare = 0.45 tons/acre

a. Water for the crop is not limiting (i.e., this is not for dry land farming)
b. Average crop yields are for dryland conditions
c. Yield is dry matter yields
d. Grown as a covercrop (cereals are harvested immature)

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Environmental Guidelines for Beef Producers

F: Reference Material

Publications and where they are available from :

1. **Agricultural Composting Handbook**/BC Ministry of Agriculture and Food.

2. **BC Livestock Watering Manual**/BC Ministry of Agriculture and Food.

3. **BC Sprinkler Irrigation Design Manual**/BC Ministry of Agriculture and Food.

4. **Beef Building System Handbook**/BC Ministry of Agriculture and Food.

5. **Canadian Farm Building Code**/The Secretary, Associate Committee on the National Building Code, National Research Council, Ottawa, Ontario, Canada, K1A 0R6.

6. **Canadian Farm Building Handbook**/Canadian Government Publishing Centre, Supply and Services Canada, Hull, Quebec, Canada, K1A 0S9.

7. **Chemigation Guidelines for BC**/BC Ministry of Agriculture and Food.

8. **Handbook for Pesticide Applicators and Dispensers**/BC Ministry of Environment, Lands and Parks.

9. **Manure Management Guidelines**/BC Ministry of Agriculture and Food.

10. **Planning Grain-Feed Handling (MWPS13)** ISBN 0893730076/Iowa State University, Ames, Iowa, U.S.A. 50011.

11. **Recommended Code of Practice for the Care and Handling of Farm Animals Beef Cattle, Publication 1870/E**/Communications Branch, Agriculture Canada, Ottawa, Ont. K1A 0C7.

12. **Soil Management Handbooks For the Lower Fraser Valley**/BC Ministry of Agriculture and Food.

13. **Soil Management Handbook For the Okanagan and Similkameen Valleys**/BC Ministry of Agriculture and Food.

14. **Ventilation Handbook**/BC Ministry of Agriculture and Food.

15. **Woodwaste Guidelines**/Department of Fisheries and Oceans, Environment Canada.

16. **BC Ministry of Agriculture and Food, Soils and Engineering Branch, Publication List. Examples of interest for beef cattle producers with environmental concerns:**

200.3081 Beware of On-Farm Manure Storage Hazards
200.3101 Pesticide Safety for Field Workers
234.0051 Suggestions for Field Sprayer Operation and Maintenance
307.000-1 BC Fencing Manual
312.100-1 Environmental Evaluation of Beef Cattle Seasonal Feeding Areas
380.7501 Manure Gases
384.2002 Rodent & Bird Control in Farm Buildings
384.2004 Rodent Control on Agricultural Land in BC
502.0005 Canada's Fish Habitat Law
502.0006 Stream Care
590.0011 Safe and Efficient Nitrogen Use
641.270-1 Ground Stabilization Using Geogrids Improving Cattle Access to Water
650.0001 Land Application of Animal Manure
652.2003 Liquid Manure (Slurry) vs Solid Manure in Crop Production

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Environmental Guidelines for Beef Producers

G: Glossary of Terms

Agriculture Protection Act:

BC Act to provide protection to farmers and ranchers that are operated using "generally accepted farming practices" that do not result in pollution.

Areas:

Grazing, Seasonal Feeding and Confined Livestock areas are defined on page 7 of this text.

BOD:

The measurement of the dissolved oxygen used by micro-organisms in the biochemical oxidation of organic matter.

Clay:

(1) A soil type characterized by a very low infiltration rate. (2) A soil consisting of particles less than 0.002 mm in equivalent diameter. (3) A soil class having material containing more than 40% clay, less than 45% sand and less than 40% silt.

Code of Agricultural Practice for Waste Management:

Attached to the Regulations of the Waste Management Act to outline environmentally sound agricultural waste practices (see Appendix C).

Denitrification:

The biochemical reduction of nitrate or nitrite to gaseous nitrogen, or an oxide of nitrogen.

Eutrophication:

Rapid aging of a lake or river. It is associated with a high concentration of plant nutrients entering a body of water.

Grass Tetany:

Cattle illness caused by eating grass deficient in magnesium. Soils high in potassium can produce grass deficient in

magnesium.

Groundwater:

Water that fills all the unblocked pores of underlying material below the water table.

Impervious:

Resistant to penetration by liquid. Soil with an infiltration rate less then 10-9 m/sec is considered impervious (typically soil with 15% clay).

Infiltration:

The downward entry of water into the soil.

Loam:

The soil class for soil having a moderate amount of sand, silt and clay. Loam soils contain 7 to 27% clay, 28 to 50% silt and less than 52% sand.

Mineralization:

The conversion of an element from an organic form to an inorganic state as a result of microbial decomposition.

Perennial:

A plant that has a life span of three years or more.

Pesticides:

Any kind of material used to kill, control or manage pests. Including insecticides, herbicides, fungicides, mitecides etc.

Pollution:

The presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment.

Precipitation:

The total amount of moisture (rain and water equivalent snow fall) that falls on an area in a given period as determined by the Canadian Atmospheric Environmental Service Reports of Environment Canada. Low precipitation is that which is 600mm (24 in) or less annual; High precipitation is over 600mm (24 in) annual.

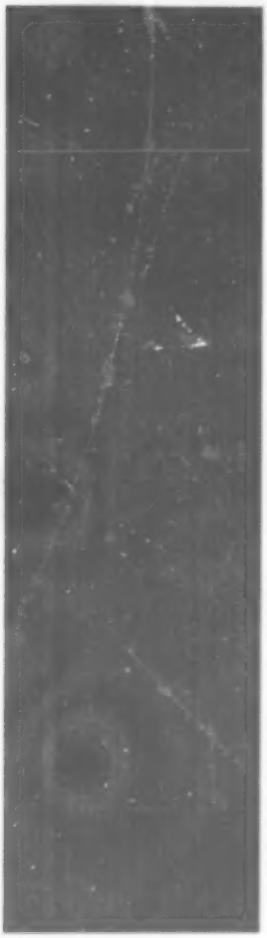
Riparian Zone:

The narrow strip of land containing moist soils and plants that borders creek, rivers or other bodies of water.

Rendering:

To process a cattle carcass for its secondary value, i.e., pet food, etc.

Sand:



A soil particle between 0.05 and 2.0 mm in diameter.

Slope (percentage):

The incline of a surface given in the number of units of change per 100 units of distance, i.e., a 4% field slope is one that slopes at 4m per 100m (4 ft per 100 feet).

Volatilization:

Chemicals going from the liquid state to the gaseous state.

Waste Management Act:

BC Act regulating waste disposal.

Watercourse:

A watercourse perennially or intermittently containing water, including a lake, river, creek, spring, ravine, swamp, salt water marsh, bog, and drainage ditch leading into any of the foregoing.

Watertable:

The level below which the soil is saturated with water.

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